BULLETIN

NATIONAL LAMP WORKS

OF GENERAL ELECTRIC CO.

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Illumination Design Data

for

Industrial and Commercial Interiors

By

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This bulletin presents a method of illumination design which has become the standard for illuminating engineering work. Through its use tedious calculations of the "point by point" method are avoided; the time required is reduced to a few minutes; and even those not experienced in lighting design, by following carefully the steps as outlined, can at once apply these data with confidence.

The method of design is known as the "lumen method." It has the decided advantage that the technical considerations which are important as influencing the result and which require the experienced judgment of the engineer, have been taken into account in the preparation of the charts and tables and therefore automatically receive due allowance in the lighting design. The data apply primarily to interiors where standard types of reflecting equipment are used to obtain general lighting of substantially uniform level.

The experienced engineer may temper rule-of-thumb methods with judgment and secure satisfactory results, but, in the final analysis, all short-cut or recipe methods which are effective must be governed by principles as given in this bulletin. For the student, the essence of illuminating engineering will be found in a studied analysis of the factors which make up the tables in their present form.

Illumination Design Data

for

Industrial and Commercial Interiors

A Handbook for
Lighting Specialists, Electrical Contractors and
Dealers, Engineers, Architects, Students,
and Instructors

ENGINEERING DEPARTMENT
NATIONAL LAMP WORKS
of General Electric Co.

Drug Store — 15 Foot-Candles

Sheet Metal Stamping — 20 Foot-Candles

The difference between good illumination which cheers the mind and comforts the senses, and poor lighting with its gloom and glare, obviously is nothing more than the difference in results as produced by modern equipment—reflectors and lamps—properly installed, and the results produced by mediocre equipment installed without regard or knowledge of principles and good practice.

ILLUMINATION DESIGN DATA
for
Industrial and Commercial Interiors

ID 90-134181 CORM 24C

1. Location of Outlets—Adequate Wiring

Lighting standards which we accept today are not only on a better level than those of a few years ago, but studies in light and vision point to even higher standards, which will unquestionably be used in the future.

The wiring plan is the foundation of the lighting system and indeed, is the step that should be given the most careful attention. Because the cost of relighting is made up so largely of wiring costs, it is far more economical, in planning a lighting installation, to provide wiring adequate for future as well as present needs.

When once outlets are properly installed as regards both spacing and size of wire, a change in type of reflector or in size of lamp, may be made without undue complication; but where the spacing of outlets is too great or the wiring inadequate, satisfactory results can never be obtained without extensive alteration.

* * * * * *

The number of outlets to provide for any given area is determined by the maximum allowable spacing between lighting units and is in turn regulated by their height above the floor. The relation between height and spacing is based on the distribution of light to procure a reasonably uniform level of illumination on the working plane. Careful analysis of the accompanying drawings will illustrate the importance of this principle.

Strictly speaking, the spacing for uniform illumination on the work depends upon the height of the light source above the surface to be illuminated, but since most work surfaces are from 2½ to 3½ feet above the floor, the spacing may for practical purposes be considered a function of the mounting height of lamps above the floor. In general, a spacing in feet which does not substantially exceed this mounting height will result in reasonably uniform illumination. See Tables 1 and 2.

When lighting units are mounted as high as the ceiling or roof trusses permit, larger and more efficient lamps may be used, while fewer units—to buy, to install, and to maintain—will be necessary. The ceiling height, or rather the height which units may be mounted clear of obstructions, therefore dictates the maximum permissible spacing.

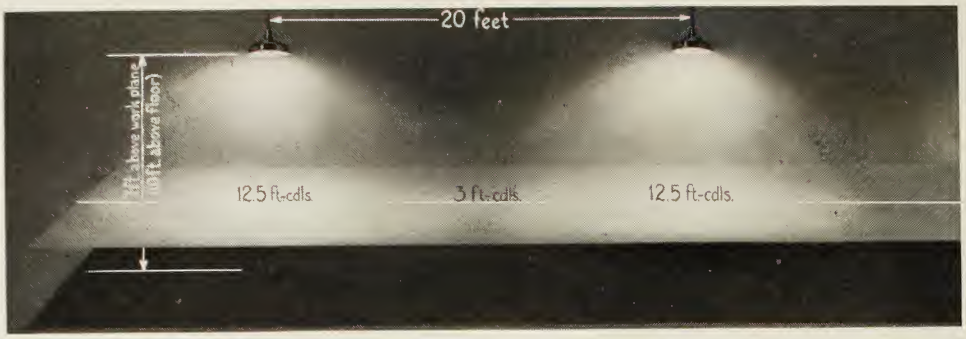


Fig. 1—Units spaced too far apart for their height furnish very uneven illumination, in this case a 4 to 1 variation, and work positions midway between units will be inadequately lighted; harsh shadows will also result. The remedy is to mount the units higher, or if that is impossible, to space them closer as shown in Fig. 2.

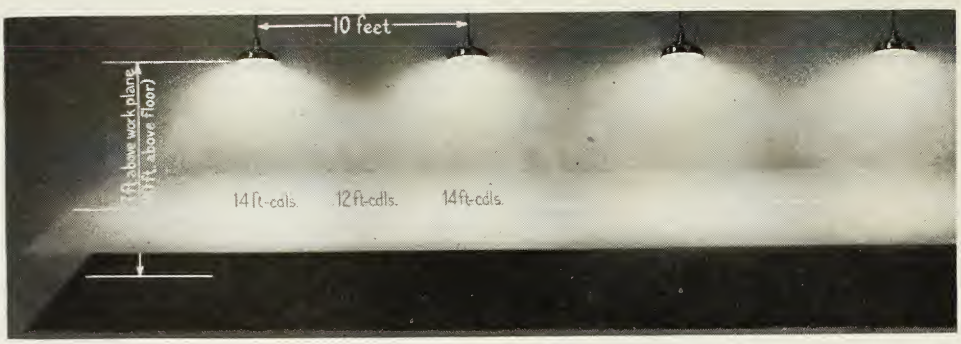


Fig. 2—It will be noted that if the permissible ratio between spacing and mounting height is not exceeded, uniform illumination will be produced. Note also the overlapping of light which serves to eliminate shadows as the units are brought closer together.

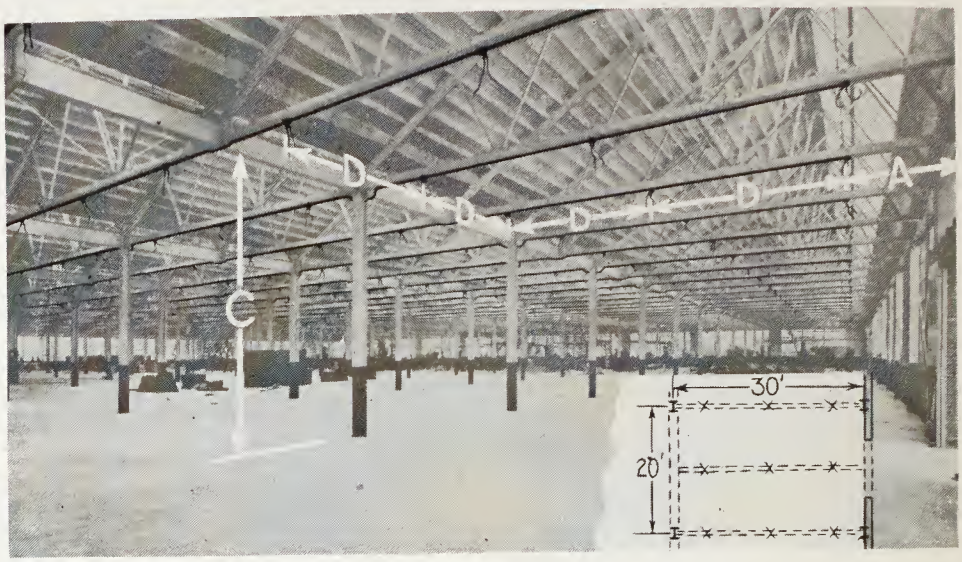
With a light source only 8 feet above the floor one unit would be required for each 55 square feet to give reasonably uniform coverage; for a 10-foot height a unit for each 125 square feet; 15-foot height, 325 square feet; 20-foot height, 650 square feet, etc.

The arrangement of bays, columns, positions of work, however, often suggests a closer spacing to conform to a symmetrical layout, or a more favorable location with respect to work positions where these are known in advance.

Specific data and typical layouts follow.

Spacing of Outlets

The location of outlets is determined by the structural features of the interior—in fact in many cases, particularly in new buildings, the wiring is installed even before the type of lighting unit is decided upon. The ceiling height therefore automatically regulates the maximum permissible spacing, assuming the units are mounted as high as possible.



The layout of lighting outlets for a large industrial building, indicating the application of data in the table below. The 13-foot clearance allows a spacing of 13 feet. For a symmetrical layout in the bays a 10-foot spacing is adopted.

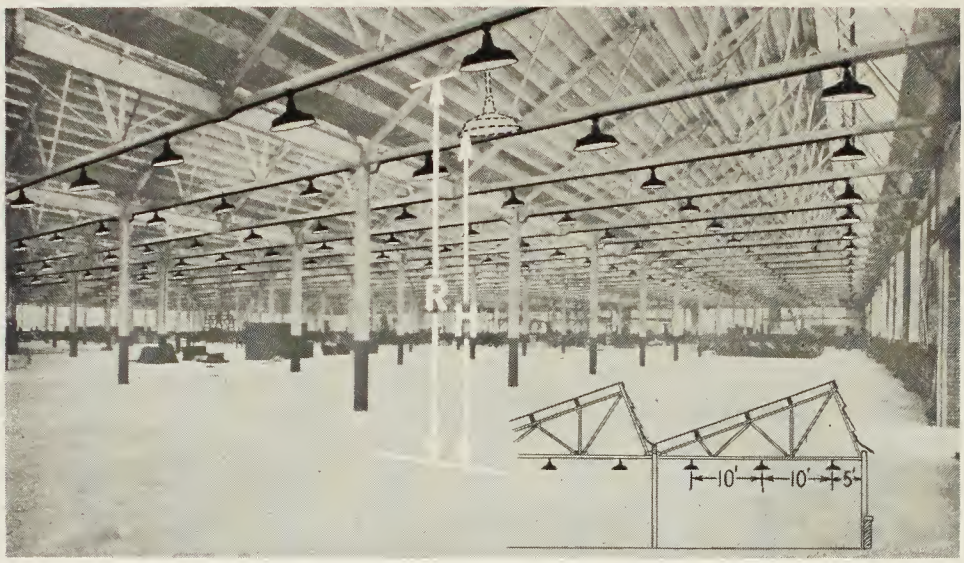
TABLE 1—SPACING OF OUTLETS

Ceiling Height (Or Height in the Clear) (C)	Spacing Between Outlets		Spacing Between Outside Outlets and Wall		Approximate Area per Outlet (At Usual Spacings)
	Usual (D)	Maximum (For Units at Ceiling) (D)	Aisles or Storage Next to Wall (A)	Desks, Work-benches, etc., Against Wall (B)	
(Feet)	(Feet)	Not more than*		Not more than*	(Square Feet)
8	7	7½	Usually	3	50–60
9	8	8		3	60–70
10	9	9	one-	3½	70–85
11	10	10½		3½	85–100
12	10–12	12	half	3½–4	100–150
13	10–12	13		3½–4½	100–150
14	10–13	15	actual	4–5	100–170
15	10–13	17		4–5	100–170
16	10–13	19	spacing	4–6	100–170
18	10–20	21		4–6	100–400
20	18–24	24	between	5–7	300–500
22	20–25	27		5–7	400–600
24	20–30	30	units	6–8	400–900
26	25–30	33		8–9	600–900
30 and up	25–30	40		8–10	600–900

* Where it is definitely known that some form of indirect lighting will be used, the maximum spacing between outlets may be increased about two feet, and the distance from the outside outlets to the wall may be increased by one foot.

Mounting Height of Lighting Units

When units are spaced less than the maximum permissible distance, they may be dropped from the ceiling for reasons of appearance, ease of cleaning, etc., but in no case should they be dropped below the minimum value shown in column (H) for a given spacing.

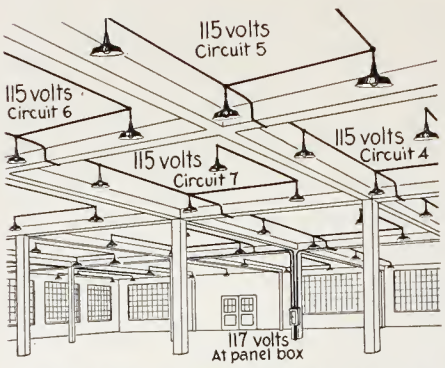


For a 10-foot spacing the units might be dropped to 10 feet above the floor as shown by the dotted outline of a reflector at height H. They are, however, mounted on the trusses 12 feet to minimize glare.

TABLE 2—MOUNTING HEIGHT OF LIGHTING UNITS

DIRECT LIGHTING UNITS				SEMI-INDIRECT AND INDIRECT LIGHTING	
Actual Spacing Between Units (D)	Distance of Units from Floor Not Less Than (H)	Desirable Mounting Height in Industrial Interiors (R)	Desirable Mounting Height in Commercial Interiors (R)	Actual Spacing Between Units (D)	Recommended Suspension Length (Top of Bowl to Ceiling) (S)
(Feet)	(Feet)	12 feet above floor if possible—to avoid glare, and still be within reach from stepladder for cleaning.	The actual hanging height should be governed largely by general appearance, but particularly in offices and drafting rooms, the minimum values shown in Column H should not be violated.	(Feet)	(Feet)
7	8			7	1–3
8	8½			8	1–3
9	9			9	1–3
10	10			10	1½–3
11	10½			11	2–3
12	11			12	2–3
14	12½	Where units are to be mounted much more than 12 feet it is usually desirable to mount the units at ceiling or on roof trusses.		14	2½–4
16	14			16	3–4
18	15			18	3–4
20	16			20	4–5
22	18			22	4–5
24	20			24	4–6
26	21			26	4–6
28	22			28	5–7
30	24			30	5–7

Adequate-Wiring Data



The **Underwriters' Code** merely specifies wiring conditions with regard to fire hazard without giving consideration to the economy of operation. The size of wire for a lighting installation may conform strictly to the code and at the same time the circuits be of such length to cause excessive voltage drop. Inadequate wiring is directly responsible for the avoidable waste of electrical energy in overloaded circuits and results in low efficiency of lamps and unsatisfactory lighting conditions.

Wattage Capacity per Outlet—Number of Outlets per Circuit—In order that a higher wattage lamp may be used in each outlet at any future date without necessitating a rearrangement of circuits, it is recommended that the capacity per outlet as given in Table 3 be allowed, and, in general, the number of outlets per circuit as follows: where the capacity is 300 watts or less, not more than 8 per circuit; where 300 to 750 watts per outlet is specified, not more than 4 per circuit; where more than 800 watts per outlet is specified, not over two should be on each circuit.

TABLE 3
ARCHITECTS' AND ELECTRICAL CONTRACTORS' WIRING GUIDE

(See Table 4 for Wire Size)

Actual Floor Area per Outlet Square Feet	CLASS A INSTALLATIONS (Such as Offices, Drafting Rooms, Factories, etc.) Wattage Capacity per Outlet	CLASS B INSTALLATIONS (Such as Stores, School Rooms) Wattage Capacity per Outlet	CLASS C INSTALLATIONS (Such as Neighborhood Stores, Storage Areas in Factories* and Basements) Wattage Capacity per Outlet	CLASS D INSTALLATIONS (Such as Storage Areas in Garages and Unimportant Basements) Wattage Capacity per Outlet
65–75	300	200	150	100
75–85	300	250	150	100
85–95	350	250	200	100
95–110	400	300	200	100
110–125	450	350	250	150
125–140	500	400	250	150
140–160	600	450	300	150
160–190	700	500	350	200
190–220	800	600	400	200
220–260	950	700	450	250
260–300	1100	800	550	300
300–340	1250	950	650	300
340–390	1450	1100	750	350
390–440	1650	1250	850	400
440–500	....	1400	950	450
500–560	....	1600	1050	500
560–630	....	1800	1200	550
630–710	....	....	1350	650
710–800	....	....	1500	750
800–900	....	....	1700	850

* In factories it is often desirable to convert storage areas into work places to meet immediate production needs. For this reason, it is recommended that storage areas be wired according to Class B specifications.

Voltage Drop—Wire sizes for all classes of lighting installations should be such that the voltage drop between the *panel box* and *outlets* does not exceed 2 volts, computed for each length of run and for an allowance in capacity per outlet as given in Table 3. Table 4 shows the wire size required for various conditions.

TABLE 4—WIRE SIZE REQUIRED

(Length of wire for a circuit is double the length of run)

WATTS PER CIRCUIT

LENGTH OF RUN (PANEL BOX TO OUTLET)	100	150	200	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
30	14	14	14	14	14	14	14	14	14	14	14	14	14	12	12	12	12	10	10	10	10	10
40	14	14	14	14	14	14	14	14	14	14	14	12	12	12	10	10	10	10	10	8	8	8
50	14	14	14	14	14	14	14	14	14	12	12	12	12	10	10	10	10	8	8	8	8	8
60	14	14	14	14	14	14	14	14	12	12	12	10	10	10	10	8	8	8	8	8	6	6
70	14	14	14	14	14	14	14	12	12	12	12	10	10	8	8	8	8	8	6	6	6	6
80	14	14	14	14	14	14	12	12	12	10	10	10	8	8	8	8	8	6	6	6	6	6
90	14	14	14	14	14	12	12	12	10	10	10	10	8	8	8	6	6	6	6	6	6	4
100	14	14	14	14	14	12	12	12	10	10	10	8	8	8	6	6	6	6	6	6	4	4
110	14	14	14	14	14	12	12	10	10	10	10	8	8	8	6	6	6	6	4	4	4	4
120	14	14	14	14	12	12	10	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4
130	14	14	14	14	12	12	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4	4
140	14	14	14	14	12	12	10	10	8	8	8	8	6	6	6	6	4	4	4	4	4	4
150	14	14	14	12	12	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4	4	2
160	14	14	14	12	12	10	10	8	8	8	8	6	6	6	4	4	4	4	4	4	2	2
170	14	14	14	12	12	10	10	8	8	8	8	6	6	6	4	4	4	4	4	2	2	2
180	14	14	14	12	10	10	10	8	8	8	6	6	6	4	4	4	4	4	2	2	2	2
190	14	14	14	12	10	10	8	8	8	8	6	6	6	4	4	4	4	4	2	2	2	2
200	14	14	14	12	10	10	8	8	8	6	6	6	6	4	4	4	4	4	2	2	2	2
210	14	14	14	12	10	10	8	8	8	6	6	6	6	4	4	4	4	4	2	2	2	2
220	14	14	14	12	10	10	8	8	8	6	6	6	6	4	4	4	4	4	2	2	2	2
230	14	14	12	12	10	8	8	8	6	6	6	6	4	4	4	4	4	2	2	2	2	1
240	14	14	12	10	10	8	8	8	6	6	6	4	4	4	4	4	2	2	2	2	1	1
250	14	14	12	10	10	8	8	8	6	6	6	4	4	4	4	2	2	2	2	2	1	1

The difference in the cost of wiring with No. 12 instead of No. 14 is so slight, and the advantages generally sufficient, that many electrical men specify No. 12 as the minimum size for branch circuits.

This table shows the wire size required for 115-volt circuits of various lengths of run, based on a drop of two volts between the panel board and the outlets. It is difficult in branch circuits, at least with present wiring methods, to use larger than No. 8 wire because of the difficulty of handling in conduit. Where the proper wire size for a proposed installation, according to this table, is larger than No. 8, it is usually best either to provide more circuits with less load, or to relocate distribution centers to decrease lengths of run. The dotted line shows the usual practical limits for circuit load and length of run.

Note—These recommendations on wiring are based on the allowances of The National Code: i. e. circuits equipped with medium screw sockets limited to 15 amperes and not more than 12 outlets per circuit; mogul sockets—limited to 40 amperes and 8 outlets per circuit. Present wiring practice is usually well within the limit allowed by the code. In some cases it is necessary to meet other requirements of local codes.

2. Foot-Candles Required

10,000 Foot-Candles
(Outdoors in Sun)

1000 Foot-Candles
(Outdoors in shade)

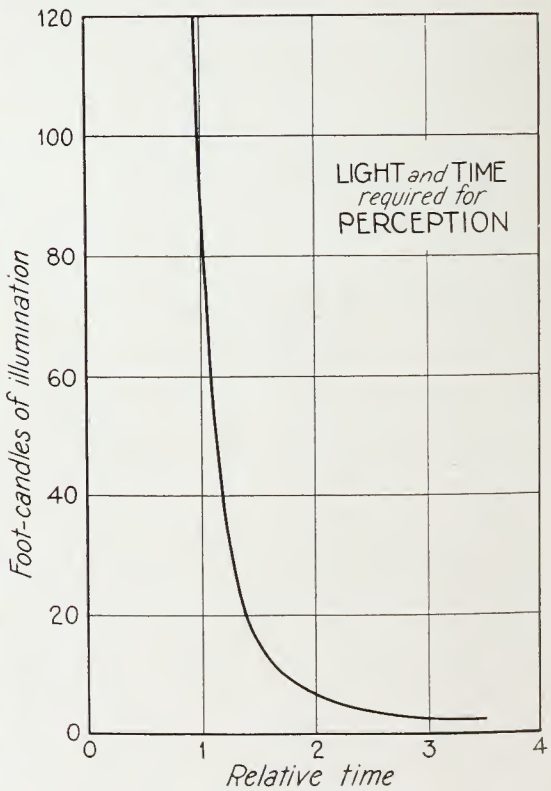
100 Foot-Candles
(Daylight near windows)

10 Foot-Candles
(Artificial light—modern system)

1 Foot-Candle
(Artificial light—old style system)

Foot-candle recommendations are based on research studies of vision, on observations of results in actual installations and, furthermore, on the adequacy of present equipment and methods to provide the desirable standard of illumination with safety and economy. All laboratory data point to the desirability of higher levels of illumination from the standpoint of vision, and practical tests substantiate the economy which results because of increased production, fewer accidents, and similar benefits.

But without regard to such factors which are basic considerations of lighting economics, because of the progress the electric industry has made, tending to lower costs of energy and lamps, 30 foot-candles cost no more today than 3 foot-candles cost twenty-five years ago.



The eye functions over wide range lighting conditions as illustrated by the photographs at the left; the graph at the right is the scientist's quantitative statement of what everybody has experienced, namely, the eye sees more and sees more quickly as the illumination level is increased.

The foot-candle values given in the following pages correspond to present standards for different classes of industrial operations, offices, stores, etc. They are merely an index to good practice. In most cases, where higher foot-candle values than shown in this table are being used, it is found that the benefits derived more than offset the slightly increased cost. The desirable illumination for any particular installation depends upon actual conditions, such as the accuracy of the operation, the fineness of detail to be observed, the color of the goods worked on or handled, and, in the case of stores, the advertising value resulting from the attractiveness of a well-lighted interior.

TABLE No. 5

Present Standards of Foot-Candles of Illumination for COMMERCIAL INTERIORS

	Foot-Candles Recommended	
	Good Practice	Minimum
Armories:		
Drill Sheds	10	6
Exhibition Halls	12	8
Art Galleries:		
General	5	3
On Paintings	25–100	10
Auditoriums	5	3
Automobile Show Rooms	15	10
Bank:		
Lobby	10	6
Cages and Offices	15	10
Barber Shop	15	10
Base Ball—Indoor Game	15	10
Basket Ball	15	10
Bowling:		
On Alley, Runway and Seats	8	5
On Pins	25	15
Billiards—General	6	4
On Table	25	15
Cars:		
Baggage, Day Coach, Dining, Pullman	8	5
Mail:		
Bag Racks	12	8
Letter Cases	15	10
Storage	6	4
Street Railway and Subway	10	6
Churches:		
Auditorium	3	2
Sunday School Room	8	5
Pulpit or Rostrum	12	8
Art Glass Windows	25–50	15
Club Rooms:		
Lounge	5	3
Reading Room	12	8
Court Rooms	10	6
Dance Halls	6	4
Dental Offices:		
Waiting Room	6	4
Operating Office	12	8
Dental Chair	50	25
Depot—Waiting Room	8	5
Drafting Room	25	15
Elevators:		
Freight and Passenger	6	4
Fire Engine House:		
When Alarm is turned in	8	5
At Other Times	3	2
Garage—Automobiles:		
Storage—Dead	3	2
Live	8	5
Repair Dept. and Washing	15	10
Gymnasiums:		
Main Exercising Floor	12	8
Swimming Pool	8	5
Shower Rooms	6	4
Locker Rooms	6	4
Fencing, Boxing, Wrestling	12	8
Halls, Passageways in Interiors	3	2
Handball	25	15
Hospitals:		
Lobby and Reception Room	6	4
Corridors	3	2
Wards (with local illumination)	5	3
Private Rooms	8	5
Night Illumination	0.2	0.1
Operating Table	100–200	75
Operating Room	15	10
Laboratories	15	10

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for COMMERCIAL INTERIORS (Continued)

	Foot-Candles Recommended	
	Good Practice	Minimum
Hotels:		
Lobby	8	5
Dining Room	6	4
Kitchen	10	6
Bed Rooms	8	5
Corridors	3	2
Writing Room	12	8
Library:		
Reading Rooms	12	8
Stack Room	6	4
Lodge Rooms	6	4
Lunch Room	12	8
Market	12	8
Moving Picture Theatre:		
During Intermission	5	3
During Pictures	..	0.1
Museum:		
General	8	5
Special Exhibits	25–100	10
Office Buildings:		
Private and General Offices—		
Close Work	15	10
No Close Work	10	8
File Room	6	4
Vault	6	4
Reception Room	6	4
Post Office:		
Lobby	10	6
Sorting, Mailing, etc	15	10
Storage	10	6
Private and General Offices	15	10
File Room and Vault	6	4
Corridors and Stairways	3	2
Railway:		
Depot—Waiting Room	8	5
Ticket Offices	12	8
Rest Room, Smoking Room	8	5
Baggage Checking Office	12	8
Storage	6	4
Concourse	6	4
Train Platform	4	2
Restaurants	8	5
Racquet	25	15
Schools:		
Auditorium	8	5
Class Rooms, Library and Office	12	8
Corridors and Stairways	5	3
Drawing	25	15
Laboratories	12	8
Manual Training	12	8
Sewing Rooms	25	15
Study Room—Desks and Blackboards	12	8
Skating Rink (Indoor)	8	5
Squash	25	15

	Foot-Candles Recommended	
	Good Practice	Minimum
Show Cases	Two to four times that of store proper	
Show Windows:		
Large Cities—		
Brightly Lighted District	150	100
Secondary Business Locations	75	50
Neighborhood Stores	50	30
Medium Cities—		
Brightly Lighted District	75	50
Neighborhood Stores	50	30
Small Cities and Towns	50	30
Lighting to Reduce Daylight Window Reflections	200–1000	..
Stores—Department and Large Specialty:		
Main Floors	15	10
Other Floors	12	8
Basement Store	15	10
Stores—Medium Size:		
Art	12	8
Automobile Supply	12	8
Bake Shop	12	8
Book	12	8
China	12	8
Cigar	15	10
Clothing	15	10
Confectionery	12	8
Dairy Products	12	8
Decorator	12	8
Drug	15	10
Dry Goods	15	10
Electrical Supply	15	10
Florist	12	8
Furrier	15	10
Grocery	12	8
Haberdashery	15	10
Hardware	12	8
Hat	15	10
Jewelry	15	10
Leather, Handbags and Trunks	12	8
Meat	12	8
Millinery	15	10
Music	12	8
Notions	12	8
Piano	12	8
Shoe	15	10
Sporting Goods	12	8
Tailor	15	10
Tobacco	15	10
Variety Store	15	10
Telephone Exchanges:		
Operating Rooms	8	5
Terminal Rooms	12	8
Cable Vaults	6	4
Tennis (Indoor)	25–50	15
Theatres:		
Auditorium	3	2
Foyer	8	5
Lobby	12	8
Toilet and Washrooms	6	4

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS

	Foot-Candles Recommended	
	Good Practice	Minimum
Aisles, Stairways, Passageways	3	2
Assembling:		
Rough	8	5
Medium	12	8
Fine	20	12
Extra Fine	50–100	25
Automobile Manufacturing:		
Automatic Screw Machines	15	10
Assembly Line	15	10
Frame Assembly	12	8
Tool Making	20	12
Body Manufacturing—Assembly, Finishing and Inspecting	50–100	25
Bakeries	12	8
Book Binding:		
Folding, Assembling, Pasting, etc.	8	5
Cutting, Punching and Stitching	12	8
Embossing	15	10
Candy Making	12	8
Canning and Preserving	12	8
Chemical Works:		
Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary or Gravity Crystallizing	5	3
Mechanical Furnaces, Generators and Stills, Mechanical Driers, Evaporators, Filtration, Mechanical Crystallizing, Bleaching	6	4
Tanks for Cooking, Extractors, Percolators, Nitrators, Electrolytic Cells	10	6
Clay Products and Cements:		
Grinding, Filter Presses, Kiln Rooms	5	3
Molding, Pressing, Cleaning and Trimming	8	5
Enameling	10	6
Color and Glazing	15	10
Cloth Products:		
Cutting, Inspecting, Sewing—		
Light Goods	15	10
Dark Goods	50–100	25
Pressing, Cloth Treating (Oil Cloth, etc.)—		
Light Goods	12	8
Dark Goods	20	12
Coal Breaking and Washing, Screening	5	3
Construction—Indoor General	5	3
Dairy Products	12	8
Electric Manufacturing:		
Storage Battery, Molding of Grids, Charging Room	10	6
Coil and Armature Winding, Mica Working, Insulating Processes	20	12
Elevator—Freight and Passenger	8	5
Engraving	50–100	25
Forge Shops and Welding	10	6
Foundries:		
Charging Floor, Tumbling, Cleaning, Pouring and Shaking Out	8	5
Rough Molding and Core Making	10	6
Fine Molding and Core Making	15	10
Garage—Automobiles:		
Storage—Dead	3	2
Live	8	5
Repair Dept. and Washing	15	10
Glass Works:		
Mix and Furnace Rooms, Pressing and Lehr, Glass Blowing Machines	10	6
Grinding, Cutting Glass to Size, Silvering	12	8
Fine Grinding, Polishing, Beveling, Inspection, Etching and Decorating	15	10
Glass Cutting (Cut Glass), Inspecting Fine	25–50	15
Glove Manufacturing:		
Light Goods—		
Cutting, Pressing, Knitting	12	8
Sorting, Stitching, Trimming and Inspecting	15	10
Dark Goods—		
Cutting, Pressing, Knitting	15	10
Sorting, Stitching, Trimming and Inspecting	50–100	25
Hat Manufacturing:		
Dyeing, Stiffening, Braiding, Cleaning and Refining—		
Light	10	6
Dark	15	10
Forming, Sizing, Pouncing, Flanging, Finishing, Ironing—		
Light	12	8
Dark	15	10
Sewing—		
Light	15	10
Dark	50–100	25

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS (Continued)

	Foot-Candles Recommended	
	Good Practice	Minimum
Ice Making:		
Engine and Compressor Room	10	6
Inspecting:		
Rough	10	6
Medium	15	10
Fine	25	15
Extra Fine	50–100	25
Polished Surfaces	Usually requires glint reflections from specially located light source	
Jewelry and Watch Manufacturing	50–100	25
Laundries and Dry Cleaning	12	8
Leather Manufacturing:		
Vats	5	3
Cleaning, Tanning and Stretching	6	4
Cutting, Fleshing and Stuffing	10	6
Finishing and Scarfing	15	10
Leather Working:		
Pressing, Winding and Glazing—		
Light	12	8
Dark	15	10
Grading, Matching, Cutting, Scarfing, Sewing—		
Light	15	10
Dark	50–100	25
Locker Rooms	6	4
Machine Shops:		
Rough Bench and Machine Work	10	6
Medium Bench and Machine Work, Ordinary Automatic Machines, Rough Grinding, Medium Buffing and Polishing	15	10
Fine Bench and Machine Work, Fine Automatic Machines, Medium Grinding, Fine Buffing and Polishing	20	12
Extra Fine Bench and Machine Work, Grinding (Fine Work)	50–100	25
Meat Packing:		
Slaughtering	8	5
Cleaning, Cutting, Cooking, Grinding, Canning, Packing	12	8
Milling—Grain Foods:		
Cleaning, Grinding and Rolling	8	5
Baking or Roasting	12	8
Flour Grading	25	15
Offices:		
Private and General—		
Close Work	15	10
No Close Work	10	8
Drafting Room	25	15
Packing:		
Crating	6	4
Boxing	10	6
Paint Manufacturing	10	6
Paint Shops:		
Dipping, Spraying, Firing	8	5
Rubbing, Ordinary Hand Painting and Finishing	12	8
Fine Hand Painting and Finishing	15	10
Extra Fine Hand Painting and Finishing (Automobile Bodies, Piano Cases, etc.)	50–100	25
Paper Box Manufacturing:		
Light	10	6
Dark	12	8
Storage of Stock	5	3
Paper Manufacturing:		
Beaters, Machine, Grinding	6	4
Calendering	10	6
Finishing, Cutting and Trimming	12	8
Plating	8	5
Polishing and Burnishing	12	8
Power Plants, Engine Rooms, Boilers:		
Boilers, Coal and Ash Handling, Storage Battery Rooms	5	3
Auxiliary Equipment, Oil Switches and Transformers	8	5
Switchboard, Engines, Generators, Blowers, Compressors	10	6
Printing Industries:		
Matrixing and Casting, Miscellaneous Machines, Presses	12	8
Proof Reading, Lithographing, Electrotyping	15	10
Linotype, Monotype, Typesetting, Imposing Stone, Engraving	50–100	25
Receiving and Shipping	6	4

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS (Continued)

	Foot-Candles Recommended	
	Good Practice	Minimum
Rubber Manufacturing and Products:		
Calendars, Compounding Mills, Fabric Preparation, Stock Cutting, Tubing Machines, Solid Tire Operations, Mechanical Goods Building, Vulcanizing	12	8
Bead Building, Pneumatic Tire Building and Finishing, Inner Tube Operation, Mechanical Goods Trimming, Treading	15	10
Sheet Metal Works:		
Miscellaneous Machines, Ordinary Bench Work	12	8
Punches, Presses, Shears, Stamps, Welders, Spinning, Fine Bench Work	15	10
Tin Plate Inspection	25	15
Shoe Manufacturing:		
Hand Turning, Miscellaneous Bench and Machine Work	12	8
Inspecting and Sorting Raw Material, Cutting, Lasting and Welting (Light)	15	10
Inspecting and Sorting Raw Material, Cutting, Stitching (Dark)	50–100	25
Soap Manufacturing:		
Kettle Houses, Cutting, Soap Chip and Powder	8	5
Stamping, Wrapping and Packing, Filling and Packing Soap Powder	10	6
Steel and Iron Mills, Bar, Sheet and Wire Products:		
Soaking Pits and Reheating Furnaces	3	2
Charging and Casting Floors	6	4
Muck and Heavy Rolling, Shearing, rough by gauge, Pickling and Cleaning	8	5
Plate Inspection, Chipping	25	15
Automatic Machines, Red, Light and Cold Rolling, Wire Drawing, Sheering, fine by line	12	8
Stone Crushing and Screening:		
Belt Conveyor Tubes, Main Line Shafting, Spaces, Chute Rooms, Inside of Bins	3	2
Primary Breaker Room, Auxiliary Breakers under Bins	5	3
Screen Rooms	8	5
Store and Stock Rooms:		
Rough bulky material	3	2
Medium or fine material requiring care	8	5
Structural Steel Fabrication	10	6
Sugar Grading	25	15
Testing:		
Rough	8	5
Fine	15	10
Extra Fine Instruments, Scales, etc	50–100	25
Textile Mills:		
(Cotton)—		
Opening and Lapping, Carding, Drawing-frame, Roving, Dyeing	8	5
Spooling, Spinning, Drawing-in, Warping, Weaving, Quilling, Inspecting, Knitting, Slashing (over beam end)	12	8
(Silk)—		
Winding, Throwing, Dyeing	12	8
Quilling, Warping, Weaving and Finishing—		
Light Goods	15	10
Dark Goods	20	15
(Woolen)—		
Carding, Picking, Washing and Combing	6	4
Twisting and Dyeing	10	6
Drawing-in, Warping—		
Light Goods	10	6
Dark Goods	15	10
Weaving—		
Light Goods	12	8
Dark Goods	20	12
Knitting Machines	15	10
Tobacco Products:		
Drying, Stripping, General	3	2
Grading and Sorting	25	15
Toilet and Wash Rooms	6	4
Upholstering:		
Automobile, Coach and Furniture	15	10
Warehouse	3	2
Woodworking:		
Rough Sawing and Bench Work	8	5
Sizing, Planing, Rough Sanding, Medium Machine and Bench Work, Gluing, Veneering, Cooperage	12	8
Fine Bench and Machine Working, Fine Sanding and Finish	15	10

TABLE No. 5 (Continued)

Foot-Candles Illumination for OUTDOOR LIGHTING

These values are included for reference purposes although the special considerations of design are not covered in this bulletin.

	Foot-Candles Recommended	
	Good Practice	Minimum
Automobile Parking Spaces	1	0.5
Baseball Diamond (Indoor Game)	10	6
Basket Ball	6	4
Bathing Beaches	1	0.5
Bulletin and Poster Boards:		
Bright Surroundings—		
Light Surface	30	20
Dark Surface	50	30
Dark Surroundings—		
Light Surface	15	10
Dark Surface	30	20
Boxing:		
Seats	3	2
Ring	80	50
Building:		
Construction Work	6	4
Excavation	2	1
Building Exteriors and Monuments—Floodlighted:		
Bright Surroundings—		
Light Surface	10	6
Dark Surface	20	15
Dark Surroundings—		
Light Surface	6	4
Dark Surface	12	8
Church Windows (Art Glass)	25–50	15
Circus:		
Seats	3	2
Arena	10	6
Clock Golf	10	6
Croquet	6	4
Dredging	2	1
Drill Fields	3	2
Flags—Floodlighted	25–50	15
Football:		
Practice	6	4
Games	12	8
Gasoline Filling Stations:		
At Pumps	15	10
Yard and Driveways	4	2
Horseshoe Pitching	6	4
Ice Hockey	8	5
Loading Docks	3	2
Lumber Yards	1	0.5
Motordromes:		
Seating	3	2
Track	15	10
Monuments (See Building Exteriors)		
Piers:		
Freight (See Loading Docks)		
Passenger	4	2
Playgrounds	4	2
Polo	8	5
Prison Yards	3	2
Protective Industrial	1	0.5
Quarries	3	2
Railway Yards:		
General	0.25	0.15
Scale House	3	2
Roque	6	4
Signs—Painted (See Poster Boards)		
Ship Yard Construction	6	4
Skating	2	1
Storage Yards	1	0.5
Swimming Pools	5	3
Target Shooting	20	15
Tennis Court	25–50	15
Toboggan Slides	2	1
Traffic Officers	20	10
Trap Shooting	15	10
Volley Ball	15	10

STREETS AND THOROUGHFARES

	Lamp Lumens per Linear Foot of Street
Business District:	
White Way—Large City	500–2000
Small City	200–500
Park Boulevards	50–100
Thoroughfares and Wholesale Districts	50–200
Residence Streets	20–40
Outlying Districts and Alleys	5–10
Highways	10–20

Reflection Factors

The proportion of light reflected by walls and ceilings of various colors, that is, their Reflection Factors, has an important bearing on both the natural and the artificial lighting. The proportion reflected will depend somewhat upon the color of the incident light. The figures here given show what proportion of

No. 1
White
Paper
80%

No. 9
Ivory
White
78%

No. 2
Gray
67%

No. 10
Caen
Stone
73%

No. 3
Gray
60%

No. 11
Ivory
71%

No. 4
Gray
54%

No. 12
Ivory
Tan
64%

No. 5
Gray
39%

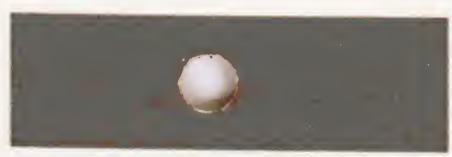
No. 13
Primrose
70%

No. 6
French
Gray
38%

No. 14
Lichen
Gray
69%

No. 7
Gray
28%

No. 15
Pearl
Gray
74%



No. 8
Gray
17%

No. 16
Silver Gray
and Caen
Stone
57%

# of Colored Surfaces

the light of MAZDA lamps these painted surfaces reflect. Reflection Factors are of special usefulness in determining the Coefficient of Utilization (ratio of light delivered at the work to total light of lamps) applicable to an interior. The Reflection Factor of any colored surface can be approximated by comparing it with these samples.

No. 17
Buff Stone and Pale Azure
36%

No. 18
Buff
54%

No. 19
Buff Stone
42%

No. 20
Tan
35%

No. 21
Cocoanut Brown
15%

No. 22
Satin Green
61%

No. 23
Bright Sage and Ivory Tan
53%

No. 24
Bright Sage
48%

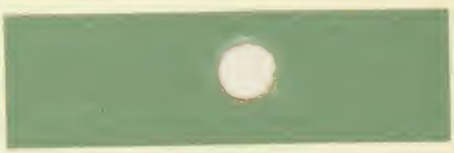
No. 25
Forest Green
18%

No. 26
Olive Green
20%

No. 27
Pale Azure and White
53%

No. 28
Pale Azure
38%

No. 29
Sky Blue
35%



No. 30
Shell Pink
49%

No. 31
Pink
49%

No. 32
Cardinal Red
18%

3. Room Efficiency and Reflector Characteristics

In order to specify the lamp size necessary to provide the foot-candles desired, the first step is to determine the percentage of light emitted by the lamp that actually gets down and is useful on the working plane. This percentage is called the Coefficient of Utilization for the particular installation.

A simple "watts per square foot" specification is unreliable unless applied with the benefit of experienced judgment of various factors which affect the result. Interior finish, size and proportions of the room, the type of reflector, and maintenance conditions are variables which must be taken into account. Unless due allowance is made for each of these the results vary, in many cases 5 to 1; in other words, the same wattage per square foot might produce 15 foot-candles under certain conditions and only 3 foot-candles under a combination of unfavorable conditions. Coefficient of Utilization Tables, Pages 24 to 29, give the net efficiency result with due regard for the important variables noted below.

Interior Finish—The paint samples show the percentage of light from MAZDA Lamps reflected by various colors; the holes in each sample permit convenient comparison with actual interior finishes. It will be noted that the influence of the interior finish is least important with opaque direct lighting reflectors, more pronounced with translucent glass units and a major consideration with semi-indirect and totally indirect luminaires.

Room Proportions (Room Index)—In general, large rooms use light more efficiently than do small rooms because there is less wall area to absorb light in proportion to floor space. Raising the light source tends to increase the proportion of wall area to floor area, thus reducing the relative efficiency of high bay installations. It will be observed that a room 10 feet square with a 10-foot ceiling has a Room Index of 1. Room Index values are computed with a unit room of this character as the basis.

The effect of room proportions on illumination efficiency, and its importance in actual design problems will be noted by comparing the Coefficient of Utilization for example, for a room having a Room Index of 0.6 against one of 5.0, other factors remaining constant.

Reflector Characteristics*—The selection of a suitable type of lighting unit depends not only upon its efficiency, the proper distribution of light and the requirements of the work, but, in the case of indirect units, upon the construction of the room and color of ceiling and walls. Decorative appearance frequently is an important item.

A lighting installation may be judged by seven fundamentals described on page 21, and in Table 7 various lighting units are rated in accordance with these criteria.

A+, A	Excellent	B	Good	C	Fair
A−, B+	Very Good	B−, C+	Very Fair	D	Unsatisfactory

The relative importance of these ratings should be carefully weighed with respect to the particular application at hand. For instance, in an office the criteria of major importance would rank: (1) Direct Glare, (2) Reflected Glare, (3) Shadows; (4) Illumination on Horizontal. On the other hand, in a foundry with lamps mounted high the order of importance would be: (1) Illumination on Horizontal, (2) Vertical Illumination, (3) Maintenance. A rating of D under Reflected Glare would not disqualify a unit except for use above polished metal or other highly glazed surfaces.

Procedure

To Determine the Coefficient of Utilization for the Installation

Refer to Table 6—Room Index, which classifies the room according to its proportions. From this table find the Room Index which corresponds most nearly to the dimensions of the installation. Apply this in the use of Table 7.

Refer to Table 7—Coefficients of Utilization, which gives the proportion of the generated light from the lamps which reaches the plane of work. The Coefficient of Utilization for the installation of the type of lighting unit selected will be found in the proper column of wall and ceiling color, opposite the correct Room Index.

*Note: It is important that good reflecting equipment be installed. The luminaires shown in Table 7 illustrate common types under which most reflectors on the market can be classified for purposes of design calculations. For example, No. 8 is a unit of a general type of which there are a great variety made by various manufacturers. Of two or more units of the same type the choice should be governed by considerations of brightness, diffusion, absorption, appearance, and cost, but not by cost alone. Of two samples of glass enclosing globes, outwardly identical, one may absorb 30% of the light and the other only 15% for the same degree of diffusion. The safest plan is to choose products of reliable manufacturers.

Illumination on Horizontal Surfaces is a prime requisite in offices, drafting rooms and those shops where the problem is to provide the best illumination for sustained vision of flat surfaces on the horizontal or slightly oblique planes in which papers, books and other flat objects are usually examined. For relative performance of various units compare coefficients of utilization for any given condition.

Illumination on Vertical Surfaces is essential in many industrial operations where working surfaces are in vertical or oblique planes. It is likewise important in stores with vertical shelving, rug racks, etc., in art museums, library stock rooms, office file rooms. Without supplementary units, the illumination on vertical surfaces from ordinary general lighting units is of the order of one-half to one-third of the horizontal illumination values.

Appearance of Lighted Room refers only to the general or casual effect produced by the complete system, and is not intended to rate the unit as to satisfaction from the standpoint of good vision or freedom from eye fatigue.

Direct Glare is the most frequent and serious cause of bad lighting. It results among other things from unshaded or inadequately shaded light sources located within the field of vision, or from too great contrast between the bright light source and a dark background or adjacent surfaces. Glare should be avoided by the use of proper reflecting and diffusing equipment.

Reflected Glare from polished working surfaces is particularly annoying because of the necessity of directing the eyes toward those surfaces, and further because the eyes are by nature especially sensitive to light rays from below. The harmful effects of this specular reflection can be minimized by properly shielding from below or diffusing the source.

Shadows, that is, differences in brightness of surfaces, are essential in observing objects in their three dimensions, but are of little or no value in the observation of flat surfaces. Where shadows are desirable, they should be soft and luminous, not so sharp and dense as to confuse the object with its shadow.

Maintenance Requirements depend upon contour of reflector, construction of fixture, and average maintenance conditions. The rating is based upon the likelihood of breakage, the labor invoved in maintaining the units at comparable degrees of efficiency, and indication given of need of cleaning.

TABLE 6

ROOM INDEX FOR NARROW AND AVERAGE ROOMS

For Indirect Lighting Use Ceiling Height	FEET						
	9 and 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30
For Direct Lighting Use Mounting Height	**FEET**						
	7 and 7½	8 and 8½	9 and 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20

Room Width (Feet)	Room Length (Feet)	ROOM INDEX						
9 (8½-9½)	8-10	1.0	0.8	0.6	0.6			
	10-14	1.0	0.8	0.8	0.6			
	14-20	1.2	1.0	0.8	0.6	0.6		
	20-30	1.2	1.2	1.0	0.8	0.6	0.6	
	30-42	1.5	1.2	1.0	0.8	0.6	0.6	0.6
	42-up	2.0	1.5	1.2	1.0	0.8	0.6	0.6
10 (9½-10½)	10-14	1.2	1.0	0.8	0.6	0.6		
	14-20	1.2	1.0	0.8	0.6	0.6	0.6	
	20-30	1.5	1.2	1.0	0.8	0.6	0.6	
	30-42	1.5	1.2	1.2	1.0	0.8	0.6	0.6
	42-60	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	60-up	2.0	1.5	1.5	1.0	1.0	0.8	0.6
12 (11-12½)	10-14	1.2	1.0	0.8	0.8	0.6	0.6	
	14-20	1.5	1.2	1.0	0.8	0.6	0.6	
	20-30	1.5	1.2	1.2	1.0	0.8	0.6	0.6
	30-42	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	42-60	2.0	1.5	1.5	1.2	1.0	0.8	0.6
	60-up	2.0	2.0	1.5	1.2	1.0	0.8	0.6
14 (13-15½)	14-20	1.5	1.2	1.0	1.0	0.8	0.6	0.6
	20-30	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	30-42	2.0	1.5	1.5	1.2	1.0	0.8	0.6
	42-60	2.0	2.0	1.5	1.5	1.0	0.8	0.6
	60-90	2.5	2.0	2.0	1.5	1.2	1.0	0.6
	90-up	2.5	2.0	2.0	1.5	1.5	1.2	0.8
17 (16-18½)	14-20	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	20-30	2.0	1.5	1.5	1.2	1.0	0.8	0.6
	30-42	2.5	2.0	1.5	1.2	1.0	1.0	0.6
	42-60	2.5	2.0	2.0	1.5	1.2	1.2	0.8
	60-110	2.5	2.0	2.0	1.5	1.2	1.2	0.8
	110-up	3.0	2.5	2.0	2.0	1.5	1.2	1.0
20 (19-21½)	20-30	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	30-42	2.5	2.0	2.0	1.5	1.2	1.0	0.8
	42-60	2.5	2.5	2.0	2.0	1.5	1.2	0.8
	60-90	3.0	2.5	2.0	2.0	1.5	1.2	1.0
	90-140	3.0	2.5	2.5	2.0	1.5	1.5	1.0
	140-up	3.0	2.5	2.5	2.0	1.5	1.5	1.0
24 (22-26)	20-30	2.5	2.0	2.0	1.5	1.2	1.0	0.8
	30-42	3.0	2.5	2.0	1.5	1.2	1.2	0.8
	42-60	3.0	2.5	2.5	2.0	1.5	1.2	1.0
	60-90	3.0	2.5	2.5	2.0	1.5	1.5	1.0
	90-140	3.0	3.0	2.5	2.0	2.0	1.5	1.2
	140-up	3.0	3.0	2.5	2.0	2.0	1.5	1.2
30 (27-33)	30-42	3.0	2.5	2.5	2.0	1.5	1.2	1.0
	42-60	3.0	3.0	2.5	2.5	1.5	1.5	1.0
	60-90	4.0	3.0	3.0	2.5	2.0	1.5	1.2
	90-140	4.0	3.0	3.0	2.5	2.0	2.0	1.5
	140-180	4.0	3.0	3.0	2.5	2.0	2.0	1.5
	180-up	4.0	3.0	3.0	2.5	2.0	2.0	1.5
36 (34-39)	30-42	4.0	3.0	2.5	2.0	1.5	1.5	1.0
	42-60	4.0	3.0	3.0	2.5	2.0	1.5	1.2
	60-90	5.0	3.0	3.0	3.0	2.0	2.0	1.5
	90-140	5.0	4.0	3.0	3.0	2.5	2.0	1.5
	140-200	5.0	4.0	3.0	3.0	2.5	2.0	1.5
	200-up	5.0	4.0	3.0	3.0	2.5	2.0	1.5
40 or more	42-60	5.0	4.0	3.0	These values are given on the opposite page			
	60-90	5.0	4.0	4.0				
	90-140	5.0	4.0	4.0				
	140-200	5.0	5.0	4.0				
	200-up	5.0	5.0	4.0				

TABLE 6

ROOM INDEX FOR LARGE HIGH ROOMS

For Indirect Lighting Use Ceiling Height	FEET							
	14 to 16½	17 to 20	21 to 24	25 to 30	31 to 36	37 to 50		
For Direct Lighting Use Mounting Height	**FEET**							
	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30	31 to 36	37 to 50

Room Width (Feet)	Room Length (Feet)	ROOM INDEX							
14 (13-15½)	14-20	1.0	0.8	0.6	0.6				
	20-30	1.0	0.8	0.6	0.6				
	30-42	1.2	1.0	0.8	0.6	0.6			
	42-60	1.5	1.0	0.8	0.6	0.6	0.6		
	60-90	1.5	1.2	1.0	0.6	0.6	0.6		
	90-up	1.5	1.5	1.2	0.8	0.6	0.6		
17 (16-18½)	14-20	1.0	0.8	0.6	0.6				
	20-30	1.2	1.0	0.8	0.6				
	30-42	1.2	1.0	1.0	0.6	0.6	0.6		
	42-60	1.5	1.2	1.2	0.8	0.6	0.6	0.6	
	60-110	1.5	1.2	1.2	0.8	0.6	0.6	0.6	
	110-up	2.0	1.5	1.2	1.0	0.8	0.6	0.6	
20 (19-21½)	20-30	1.2	1.0	0.8	0.6	0.6			
	30-42	1.5	1.2	1.0	0.8	0.6	0.6		
	42-60	2.0	1.5	1.2	0.8	0.6	0.6	0.6	
	60-90	2.0	1.5	1.2	1.0	0.6	0.6	0.6	
	90-140	2.0	1.5	1.5	1.0	0.8	0.8	0.6	0.6
	140-up	2.0	1.5	1.5	1.0	1.0	0.8	0.6	0.6
24 (22-26)	20-30	1.5	1.2	1.0	0.8	0.6	0.6		
	30-42	1.5	1.2	1.2	0.8	0.6	0.6		
	42-60	2.0	1.5	1.2	1.0	0.8	0.6	0.6	
	60-90	2.0	1.5	1.5	1.0	0.8	0.6	0.6	0.6
	90-140	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	140-up	2.0	2.0	1.5	1.2	1.0	0.8	0.8	0.6
30 (27-33)	30-42	2.0	1.5	1.2	1.0	0.8	0.6	0.6	
	42-60	2.5	1.5	1.5	1.0	1.0	0.8	0.6	
	60-90	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	90-140	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6
	140-180	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6
	180-up	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6
36 (34-39)	30-42	2.0	1.5	1.5	1.0	0.8	0.8	0.6	
	42-60	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	60-90	3.0	2.0	2.0	1.5	1.0	1.0	0.6	0.6
	90-140	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	140-200	3.0	2.5	2.0	1.5	1.5	1.2	1.0	0.8
	200-up	3.0	2.5	2.0	1.5	1.5	1.2	1.0	0.8
42 (40-45)	42-60	3.0	2.0	1.5	1.2	1.0	0.8	0.8	0.6
	60-90	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	90-140	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.6
	140-200	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8
	200-up	3.0	2.5	2.5	2.0	1.5	1.5	1.2	0.8
50 (46-55)	42-60	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	60-90	3.0	3.0	2.5	1.5	1.5	1.2	1.0	0.6
	90-140	3.0	3.0	2.5	2.0	1.5	1.5	1.2	0.8
	140-200	3.0	3.0	2.5	2.0	2.0	1.5	1.2	0.8
	200-up	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0
60 (56-67)	60-90	4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8
	90-140	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0
	140-200	4.0	3.0	3.0	2.5	2.0	1.5	1.5	1.0
	200-up	4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.0
75 (68-90)	60-90	5.0	4.0	3.0	2.5	2.0	1.5	1.2	0.8
	90-140	5.0	4.0	3.0	2.5	2.0	1.5	1.5	1.0
	140-200	5.0	4.0	4.0	3.0	2.5	2.0	1.5	1.2
	200-up	5.0	4.0	4.0	3.0	2.5	2.0	1.5	1.2
90 or more	60-90	5.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0
	90-140	5.0	5.0	4.0	3.0	2.5	2.0	1.5	1.2
	140-200	5.0	5.0	4.0	3.0	2.5	2.0	1.5	1.2
	200-up	5.0	5.0	4.0	3.0	3.0	2.5	2.0	1.5

TABLE No. 7
A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

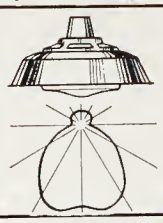
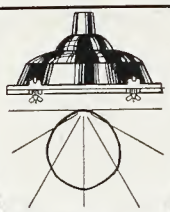
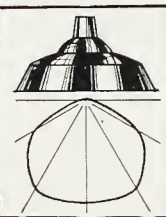
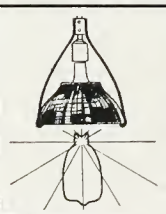
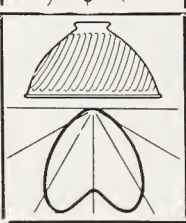
LIGHTING UNIT		RELATIVE FOOT-CANDLES FOR A GIVEN LAMP SIZE		APPEARANCE OF LIGHTED ROOM	DIRECT GLARE	REFLECTED GLARE	SHADOWS	MAINTENANCE
		On Horizontal	On Vertical					
Direct Lighting—General Industrial Reflectors								
1 **RLM** White Bowl Lamp 90° to 180°—0% 0° to 90°—66%		A Excellent	B Good	B Good	B+ Very Good	B Good	B+ Very Good	A− Very Good
2 **Glassteel Diffuser** Clear Lamp 90° to 180°—7% 0° to 90°—60%		A− Very Good	B Good	A− Very Good	A− Very Good	B+ Very Good	A Excellent	B Good
Special RLM Applications								
3 **RLM Dome Dust-tight Cover** 90° to 180°—0% 0° to 90°—54%		B Good	B− Very Fair	B Good	B Good	B− Very Fair	B+ Very Good	A+ Excellent
4 **RLM Dome** Clear Lamp 90° to 180°—0% 0° to 60°—76%		A+ Excellent	B+ Very Good	C+ Very Fair	C Satisfactory above 20-foot mounting Height	D Unsatisfactory above Polished Surfaces	C+ Very Fair	A+ Excellent
Industrial Reflectors for High Narrow Bays								
5 **Concentrated Prismatic Reflector Aluminum Cover** Clear Lamp 90° to 180°—14% 0° to 90°—65%		A+ Excellent	B Good	B Good	C+ Very Fair	D Unsatisfactory above Polished Surfaces	C Fair	A Excellent
6 **Mirrored Glass Reflector** Clear Lamp 90° to 180°—0% 0° to 60°—70%		A+ Excellent	B Good	B Good	C+ Very Fair	D Unsatisfactory above Polished Surfaces	C Fair	A Excellent
7 **Polished Aluminum Reflector** Clear Lamp 90° to 180°—0% 0° to 90°—72%		A+ Excellent	B Good	B Good	C Very Fair	D Unsatisfactory above Polished Surfaces	C+ Fair	A− Very Good

TABLE No. 7
AND COEFFICIENTS OF UTILIZATION

PROBABLE AVERAGE ILLUMINATION—AS FRACTION OF INITIAL ILLUMINATION			CEILING	VERY LIGHT (70%)			FAIRLY LIGHT (50%)			FAIRLY DARK (30%)	
			WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean Conditions	Average Conditions	Dirty Conditions	ROOM INDEX	COEFFICIENTS OF UTILIZATION							
Calculation Data—General Units											
.80	.75	.65	0.6	.32	.28	.25	.32	.28	.25	.27	.25
			0.8	.40	.36	.34	.39	.35	.33	.35	.33
			1.0	.43	.39	.37	.42	.39	.37	.39	.37
			1.2	.46	.43	.41	.45	.43	.41	.43	.41
			1.5	.48	.45	.43	.47	.45	.43	.45	.43
			2.0	.52	.50	.48	.51	.49	.47	.49	.47
			2.5	.56	.54	.52	.55	.53	.51	.53	.51
			3.0	.57	.55	.53	.56	.54	.52	.54	.52
			4.0	.60	.58	.56	.59	.57	.55	.57	.55
			5.0	.61	.59	.57	.60	.58	.57	.58	.56
.75	.70	.60	0.6	.29	.25	.21	.28	.24	.21	.23	.21
			0.8	.36	.32	.29	.35	.31	.28	.31	.28
			1.0	.39	.36	.33	.38	.35	.33	.34	.32
			1.2	.42	.39	.36	.41	.38	.36	.37	.35
			1.5	.45	.42	.39	.43	.40	.38	.39	.38
			2.0	.49	.46	.43	.48	.45	.43	.44	.42
			2.5	.53	.50	.47	.51	.49	.47	.47	.46
			3.0	.54	.52	.49	.52	.50	.49	.49	.47
			4.0	.57	.55	.53	.55	.53	.51	.51	.50
			5.0	.58	.56	.54	.56	.54	.53	.52	.51
Calculation Data—RLM Special Service											
.80	.75	.70	0.6	.29	.26	.24	.28	.26	.24	.26	.24
			0.8	.35	.32	.31	.34	.32	.31	.32	.30
			1.0	.37	.36	.35	.37	.35	.34	.35	.34
			1.2	.40	.38	.37	.39	.38	.37	.37	.37
			1.5	.42	.41	.38	.41	.39	.38	.39	.38
			2.0	.44	.43	.41	.44	.43	.41	.42	.41
			2.5	.48	.45	.44	.46	.45	.44	.44	.44
			3.0	.49	.47	.45	.48	.46	.45	.45	.44
			4.0	.50	.48	.48	.49	.47	.46	.46	.46
			5.0	.52	.49	.48	.50	.48	.47	.48	.46
.80	.75	.70	0.6	.34	.29	.24	.34	.29	.24	.28	.24
			0.8	.42	.38	.34	.42	.37	.33	.37	.33
			1.0	.46	.43	.39	.45	.42	.39	.42	.39
			1.2	.50	.47	.43	.49	.46	.43	.45	.42
			1.5	.53	.50	.46	.52	.49	.46	.48	.45
			2.0	.58	.55	.51	.57	.54	.51	.53	.51
			2.5	.62	.59	.56	.61	.58	.56	.58	.56
			3.0	.64	.61	.58	.63	.60	.58	.60	.58
			4.0	.67	.65	.63	.66	.64	.62	.63	.61
			5.0	.69	.67	.65	.67	.66	.64	.65	.63
Calculation Data—High Bay Units											
.80	.75	.65	0.6	.40	.37	.36	.39	.37	.35	.38	.34
			0.8	.48	.46	.45	.46	.45	.44	.44	.42
			1.0	.52	.50	.49	.50	.48	.48	.48	.46
			1.2	.55	.54	.53	.54	.52	.50	.51	.48
			1.5	.58	.57	.55	.55	.54	.53	.53	.50
			2.0	.61	.60	.58	.59	.58	.56	.56	.52
			2.5	.65	.62	.61	.62	.60	.59	.58	.55
			3.0	.66	.65	.63	.63	.62	.60	.59	.56
			4.0	.68	.66	.65	.64	.63	.62	.60	.57
			5.0	.70	.68	.66	.66	.64	.63	.61	.58
.80	.70	.60	0.6	.40	.38	.36	.39	.38	.36	.39	.36
			0.8	.48	.46	.45	.47	.45	.44	.45	.43
			1.0	.51	.50	.49	.50	.49	.48	.50	.48
			1.2	.54	.53	.52	.53	.52	.51	.52	.50
			1.5	.57	.56	.54	.56	.55	.54	.54	.53
			2.0	.60	.59	.57	.59	.58	.57	.57	.56
			2.5	.63	.61	.60	.61	.60	.59	.59	.58
			3.0	.64	.63	.61	.63	.61	.60	.60	.59
			4.0	.65	.64	.63	.64	.62	.61	.61	.60
			5.0	.67	.65	.64	.64	.63	62	.62	.61
.80	.70	.60	0.6	.41	.39	.37	.40	.39	.37	.40	.37
			0.8	.49	.47	.47	.48	.47	.46	.47	.44
			1.0	.52	.52	.51	.52	.51	.50	.51	.50
			1.2	.55	.54	.54	.54	.54	.52	.54	.52
			1.5	.59	.57	.56	.57	.56	.55	.56	.54
			2.0	.61	.60	.59	.60	.60	.58	.59	.57
			2.5	.65	.63	.62	.63	.62	.61	.61	.6p
			3.0	.66	.65	.63	.64	.63	.62	.62	.61
			4.0	.67	.65	.65	.65	.64	.63	.63	.62
			5.0	.69	.67	.65	.66	.65	.64	.64	.63

TABLE No. 7 (Continued)
A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

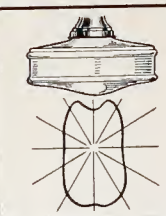
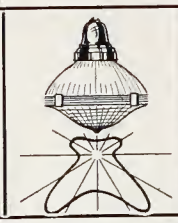
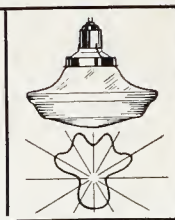
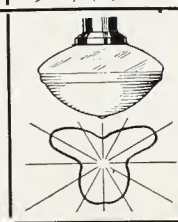
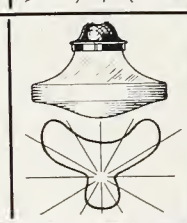
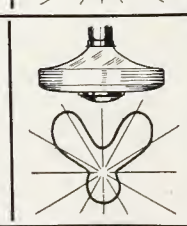
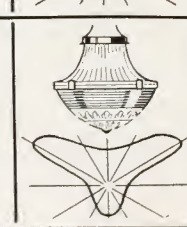
LIGHTING UNIT		RELATIVE FOOT-CANDLES FOR A GIVEN LAMP SIZE		APPEARANCE OF LIGHTED ROOM	DIRECT GLARE	REFLECTED GLARE	SHADOWS	MAINTENANCE
		On Horizontal	On Vertical					
Store and General Utility Enclosing Units								
8 **Flattened White Glass Enclosing Globe** 90° to 180°—35% 0° to 90°—45%		B+ Very Good	B+ Very Good	A Excellent	B Good	B+ Very Good	A− Very Good	B+ Very Good
9 **Prismatic Glass Enclosing Unit** 90° to 180°—27% 0° to 90°—53%		A− Very Good	B+ Very Good	A Excellent	B Good	B− Very Fair	B Good	B Good
Enclosed Semi-Indirect Lighting Units								
10 **Enclosed Semi-Indirect Enameled Bottom Etched Top Skeleton Glass Holder** 90° to 180°—50% 0° to 90°—27%		B− Very Fair	B− Very Fair	A Excellent	A− Very Good	B+ Very Good	A− Very Good	B Good
11 **Enclosed Semi-Indirect Enameled Bottom Etched Top** 90° to 180°—48% 0° to 90°—32%		B Good	B− Very Fair	A Excellent	A− Very Good	B+ Very Good	A− Very Good	B Good
12 **Enclosed Semi-Indirect Enameled Bottom Etched Top** (Close Ceiling Only) 90° to 180°—53% 0° to 90°—22%		B− Very Fair	C+ Very Fair	A Excellent	A Excellent	A− Very Good	A Excellent	B Good
13 **Enclosed Semi-Indirect Cased-Glass Bottom Etched Top** 90° to 180°—51% 0° to 90°—21%		C+ Very Fair	C+ Very Fair	A Excellent	A Excellent	A Excellent	A Excellent	B− Very Fair
14 **Enclosed Semi-Indirect Prismatic Glass** 90° to 180°—69% 0° to 90°—17%		B− Very Fair	C+ Very Fair	A Excellent	A Excellent	A Excellent	A Excellent	B Good

TABLE No. 7 (Continued)
AND COEFFICIENTS OF UTILIZATION

PROBABLE AVERAGE ILLUMINATION—AS FRACTION OF INITIAL ILLUMINATION			CEILING	VERY LIGHT (70%)			FAIRLY LIGHT (50%)			FAIRLY DARK (30%)	
			WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean Condition	Average Condition	Dirty* Condition	ROOM INDEX	COEFFICIENTS OF UTILIZATION							
Calculation Data—Enclosing Units											
.80	.75	.65	0.6	.22	.17	.14	.20	.16	.13	.14	.12
			0.8	.27	.22	.19	.25	.21	.18	.19	.17
			1.0	.31	.26	.23	.28	.24	.21	.22	.19
			1.2	.35	.30	.26	.31	.27	.24	.25	.22
			1.5	.38	.33	.29	.34	.30	.27	.27	.24
			2.0	.42	.38	.33	.38	.34	.31	.31	.28
			2.5	.46	.41	.37	.41	.37	.34	.34	.31
			3.0	.49	.45	.40	.43	.39	.36	.36	.33
			4.0	.53	.48	.44	.47	.43	.40	.38	.36
			5.0	.55	.51	.47	.49	.45	.42	.40	.38
.80	.70	.60	0.6	.28	.22	.18	.26	.21	.17	.19	.16
			0.8	.35	.29	.25	.33	.28	.24	.26	.23
			1.0	.38	.33	.29	.36	.32	.28	.30	.27
			1.2	.43	.37	.33	.40	.35	.31	.33	.30
			1.5	.46	.41	.36	.43	.38	.34	.35	.33
			2.0	.51	.46	.42	.47	.43	.40	.40	.38
			2.5	.55	.51	.46	.51	.47	.44	.44	.42
			3.0	.58	.54	.50	.54	.50	.47	.46	.44
			4.0	.62	.58	.55	.57	.54	.51	.50	.48
			5.0	.65	.61	.57	.60	.56	.53	.52	.50
Calculation Data—Semi-Indirect and Indirect Units											
.75	.70	. . .	0.6	.17	.13	.10	.14	.11	.09	.08	.07
			0.8	.21	.17	.14	.18	.14	.12	.12	.10
			1.0	.24	.20	.17	.21	.17	.15	.14	.12
			1.2	.28	.23	.20	.23	.19	.17	.16	.14
			1.5	.31	.26	.23	.26	.22	.19	.18	.16
			2.0	.35	.30	.27	.29	.25	.22	.20	.18
			2.5	.38	.34	.30	.32	.28	.25	.23	.20
			3.0	.41	.37	.33	.34	.30	.27	.25	.22
			4.0	.45	.41	.37	.37	.34	.31	.27	.25
			5.0	.47	.43	.40	.39	.36	.33	.29	.27
.75	.70	. . .	0.6	.19	.14	.11	.16	.12	.10	.10	.08
			0.8	.24	.19	.16	.21	.16	.14	.14	.12
			1.0	.27	.22	.19	.23	.19	.17	.16	.14
			1.2	.30	.25	.22	.26	.22	.19	.18	.16
			1.5	.34	.29	.25	.29	.25	.22	.20	.18
			2.0	.38	.33	.29	.32	.28	.25	.23	.21
			2.5	.41	.37	.33	.35	.32	.28	.26	.24
			3.0	.44	.40	.36	.38	.34	.31	.28	.26
			4.0	.49	.44	.40	.41	.37	.35	.31	.29
			5.0	.51	.47	.43	.43	.39	.37	.33	.31
.75	.70	. . .	0.6	.18	.14	.11	.15	.12	.10	.09	.08
			0.8	.22	.18	.16	.19	.15	.13	.12	.11
			1.0	.25	.21	.19	.21	.18	.16	.15	.12
			1.2	.28	.24	.21	.24	.20	.18	.16	.14
			1.5	.31	.27	.24	.26	.22	.20	.18	.16
			2.0	.35	.31	.28	.29	.26	.23	.20	.19
			2.5	.38	.34	.31	.31	.29	.26	.23	.21
			3.0	.40	.37	.34	.33	.31	.28	.24	.22
			4.0	.44	.41	.38	.36	.34	.32	.26	.25
			5.0	.46	.43	.40	.38	.35	.33	.28	.26
.75	.65	. . .	0.6	.16	.12	.10	.13	.10	.08	.08	.07
			0.8	.20	.16	.14	.17	.14	.11	.11	.09
			1.0	.23	.19	.17	.19	.16	.14	.13	.11
			1.2	.26	.22	.19	.22	.18	.16	.14	.13
			1.5	.29	.25	.21	.24	.20	.19	.16	.14
			2.0	.32	.28	.25	.27	.23	.21	.18	.17
			2.5	.35	.31	.28	.29	.26	.24	.20	.19
			3.0	.38	.34	.31	.31	.28	.26	.22	.21
			4.0	.41	.38	.35	.34	.31	.29	.24	.23
			5.0	.43	.39	.37	.36	.33	.31	.26	.24
.75	.70	. . .	0.6	.18	.14	.11	.14	.11	.09	.07	.06
			0.8	.22	.18	.15	.18	.14	.12	.10	.09
			1.0	.25	.21	.18	.20	.17	.14	.12	.10
			1.2	.29	.24	.21	.23	.19	.17	.14	.12
			1.5	.33	.28	.24	.26	.22	.19	.16	.14
			2.0	.36	.32	.28	.29	.25	.22	.18	.16
			2.5	.40	.35	.32	.31	.28	.25	.20	.18
			3.0	.43	.38	.35	.33	.30	.27	.22	.20
			4.0	.47	.43	.39	.37	.34	.31	.24	.23
			5.0	.49	.45	.42	.39	.36	.33	.26	.24

* Semi-indirect and indirect units unsuitable under very dirty conditions or where ceiling and sidewalls are very dark colored.

TABLE No. 7 (Continued)
A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

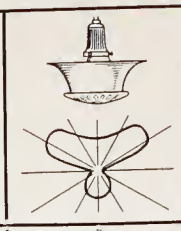
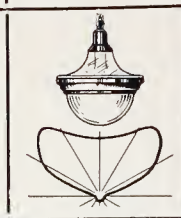
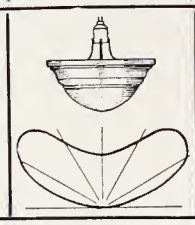
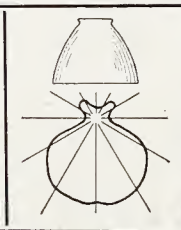
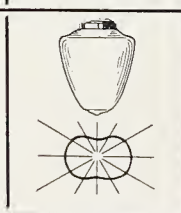
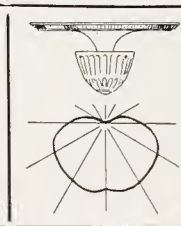
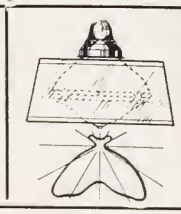
LIGHTING UNIT		RELATIVE FOOT-CANDLES FOR A GIVEN LAMP SIZE		APPEARANCE OF LIGHTED ROOM	DIRECT GLARE	REFLECTED GLARE	SHADOWS	MAINTENANCE
		On Horizontal	On Vertical					
Semi-Indirect and Indirect Lighting Units								
15 **Open Semi-Indirect Enameled Deflector Dense Glass Bottom Plate** 90° to 180°—54% 0° to 90°—18%		B− Very Fair	C Fair	A Excellent	A− Very Good	B+ Very Good	A− Very Good	C Fair
16 **Enclosed Luminous Bowl Indirect** 90° to 180°—64% 0° to 90°—6%		C+ Very Fair	C Fair	A Excellent	A+ Excellent	A+ Excellent	A Excellent	B− Very Fair
17 **Open Indirect** 90° to 180°—80% 0° to 90°—0%		C+ Very Fair	C Fair	B+ Very Good	A+ Excellent	A+ Excellent	A+ Excellent	C Fair
SPECIAL UNITS FOR COMMERCIAL INTERIORS								
18 **Dense White Glass Reflector** Frosted Lamp 90° to 180°—12% 0° to 90°—70%		Recommended in sizes of 100 watts and below. In larger sizes, glare and shadows make the open type unit less satisfactory than totally enclosing white units. Its principal application is in such locations as small rooms, closets, stock bin aisles, and other places of occasional use where low wattage lamps are suitable. Coefficients of Utilization average about the same as for Unit No. 9.						
19 **Round and Stalactite Globes** 90° to 180°—38% 0° to 90°—42%		Units of this type merely diffuse the light and do not appreciably improve the distribution of light as obtained from a bare lamp. Flattened units like No. 8 distribute light more efficiently downward and are usually to be preferred. Stalactite and spherical globes are, however, applicable in waiting rooms, banks and other interiors including certain stores where little importance is attached to the efficient distribution of light. Coefficients of Utilization about 10% lower than values given for Unit No. 8.						
20 **Large Opaque Reflector Open Diffusing Bowl** 90° to 180°—13% 0° to 90°—60%		The diffusing qualities in both the bowl and the large diameter reflector render the unit low in brightness with corresponding freedom from glare and sharp shadows. From the standpoint of dirt collection it retains the disadvantage of the open bowl. This unit is applicable for close ceiling mounting, permitting a wider spacing between units often desirable in large stores; it serves well in interiors where indirect lighting is preferred but impractical because of unfavorable ceiling finish. Coefficients of Utilization slightly higher than those given for Unit No. 8.						
21 **Enclosing Unit Large Decorative Shade** 90° to 180°—21% 0° to 90°—56%		Paper, parchment, silk, or other material may often be effectively used as shades in connection with enclosed opal glass or prismatic units. Such shades not only add an element of decoration, lending themselves to a variety of designs or stencils, but they are also effective in reducing the candlepower and brightness in the direction of the eye, with slight loss in efficiency. Very suitable in exclusive stores and certain millinery or clothing sections of department stores. Shades can be added to existing fixtures. Coefficients of Utilization a little lower than those for Unit No. 8.						

TABLE No. 7 (Continued)
AND COEFFICIENT OF UTILIZATION

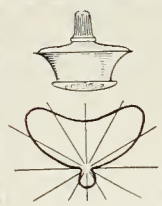
PROBABLE AVERAGE ILLUMINATION—AS FRACTION OF INITIAL ILLUMINATION			CEILING	VERY LIGHT (70%)			FAIRLY LIGHT (50%)			FAIRLY DARK (30%)	
			WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean Condition	Average Condition	Dirty* Condition	ROOM INDEX	COEFFICIENTS OF UTILIZATION							
.70	.60	. . .	0.6	.18	.15	.13	.15	.12	.10	.10	.08
			0.8	.22	.19	.17	.19	.16	.14	.13	.11
			1.0	.25	.22	.20	.21	.18	.16	.15	.13
			1.2	.28	.25	.22	.24	.21	.19	.16	.15
			1.5	.31	.27	.24	.26	.22	.21	.17	.16
			2.0	.34	.31	.28	.28	.25	.24	.20	.19
			2.5	.37	.34	.32	.30	.28	.26	.22	.21
			3.0	.39	.36	.34	.32	.29	.28	.23	.22
			4.0	.43	.40	.37	.34	.32	.31	.25	.24
			5.0	.44	.41	.40	.36	.34	.32	.26	.25
.75	.65	. . .	0.6	.14	.11	.10	.11	.09	.07	.06	.05
			0.8	.18	.14	.13	.14	.11	.10	.07	.06
			1.0	.20	.17	.15	.15	.13	.11	.09	.07
			1.2	.23	.20	.17	.18	.15	.13	.10	.09
			1.5	.26	.22	.19	.20	.17	.15	.11	.10
			2.0	.29	.26	.23	.22	.19	.17	.13	.12
			2.5	.31	.28	.26	.24	.21	.20	.14	.13
			3.0	.34	.31	.28	.25	.23	.21	.15	.14
			4.0	.37	.34	.32	.27	.26	.24	.17	.16
			5.0	.39	.36	.34	.30	.27	.26	.18	.17
.70	.60	. . .	0.6	.15	.12	.10	.11	.09	.07	.05	.04
			0.8	.18	.15	.13	.13	.11	.09	.07	.06
			1.0	.22	.19	.16	.15	.13	.11	.08	.07
			1.2	.25	.22	.19	.18	.15	.13	.09	.08
			1.5	.27	.24	.21	.20	.17	.15	.10	.09
			2.0	.30	.27	.25	.22	.19	.17	.11	.10
			2.5	.34	.31	.28	.24	.22	.20	.13	.12
			3.0	.36	.33	.30	.26	.24	.22	.14	.13
			4.0	.40	.37	.34	.28	.26	.24	.15	.14
			5.0	.42	.39	.37	.30	.28	.26	.17	.15

SPECIAL UNITS FOR COMMERCIAL INTERIORS

22

Enclosed Semi-Indirect Enameled Deflector Etched Glass Top

90° to 180°—48%
0° to 90°—10%



Units of this design have the same character of distribution as open types, with cover plate serving to exclude the dust and dirt from the lamp and reflecting surfaces of the unit. They have the decided advantage from the standpoint of cleaning accompanied, however, by considerable sacrifice in the total light output of the unit.

Coefficients of Utilization about 20% less than open top units of the same design.

23

Ornamental Lantern Art Glass Panels Diffusing Bottom Plate Internal Reflector

90° to 180°—8%
0° to 90°—40%

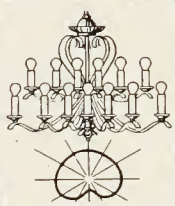
Lanterns of period designs to conform architecturally to interiors, are frequently used in public buildings, notably churches. Reflectors inside of the ornamental housing increase the lighting efficiency and if made of glass may be made to transmit varying amounts of light to illuminate the side panels. Subject to a variety of design in which distribution ranges from direct to totally indirect lighting.

Coefficients of Utilization for the type of unit illustrated will average about two-thirds of the values given for Unit No 2.

24

Multiple Light Clusters

Small Frosted Lamps



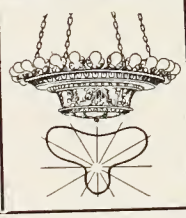
Multi-light clusters are in favor as decorative elements in public buildings and other monumental interiors. When mounted high with a large number of low wattage lamps, the result is not unsatisfactory. However, when mounted low, the uncontrolled distribution of light and the glare from the unshielded sources, spoils what would otherwise be an artistic effect.

Lighting efficiency about 50% lower than same wattage in single lamp unit.

25

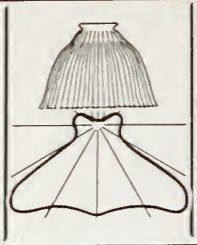
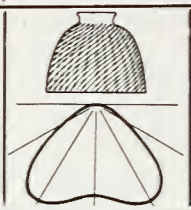
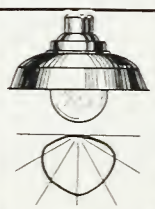
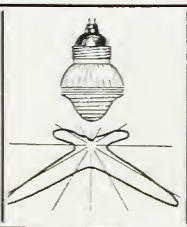
Large Main Unit

Small Decorative Lamps



The application of shades to multi-light units will, in many instances, raise the over-all effectiveness of the installation. On the other hand, the illuminating qualities of large decoration designs can be materially improved if the decorative lamp clusters are built around a central large-lamp unit either of the indirect type or of dense enclosing glassware. A combination of this sort offers a greater flexibility in control of lighting effects, and, in most cases, will allow the illumination level to be raised by the use of a larger lamp in the main unit at any time if the occasion requires.

TABLE No. 7 (Continued)
SPECIAL PURPOSE INDUSTRIAL UNITS

26 **Deep Bowl Enameled Steel** Clear Lamp 90° to 180°—0% 0° to 90°—65%		Generally inferior to RLM Dome with white-bowl lamp because of lower efficiency, sharp shadows, and reflected glare when used above shiny surfaces. Contrary to a common impression the light at any angle from a deep bowl steel reflector is generally less than that from the RLM Standard Dome. Coefficients of Utilization average about 15% lower than those given for Unit No. 4.
27 **Prismatic Reflector** Clear Lamp 90° to 180°—20% 0° to 90°—74%		Highly efficient reflector which, by modification in design, can be made to give extensive, broad, or narrow light distribution characteristics. With clear lamps it is difficult to avoid sharp shadows and reflected glare, and these factors are serious handicaps to a more general use of this type of unit, particularly at usual mounting heights. White-bowl lamps, properly positioned, help these factors, although their use sacrifices, to some extent, accurate control of light distribution as well as the efficiency. Coefficients of Utilization about 15% higher than those given for Unit No. 9.
28 **Mirrored Glass Reflector** Clear Lamp 90° to 180°—0% 0° to 90°—69%		This unit like all deep-bowl types has a large shielding angle to protect against direct glare; it likewise has the disadvantage in that it does not protect against reflected glare nor does it avoid sharp shadows when used with clear lamps. The use of white-bowl lamps lowers the efficiency of the unit about 20%, due to the light being bottled up in the reflector, and, in general, are not recommended. Coefficients of Utilization are about 10% lower than those given for Unit No. 4.
29 **Concentrating Aluminum Reflector Dust-tight Housing** 90° to 180°—0% 0° to 90°—57%		This unit has an aluminum reflector inside of a dust tight housing. The reflector insert gives a concentrated distribution and a consequent higher utilization factor in high narrow interiors than would be the case with Unit No. 3. Its lower efficiency, compared to Unit No. 7, limits the use of this unit to locations where excessive dirt and smoke prevail. Coefficients of Utilization average about 20% lower than those given for Unit No. 7.
30 **Vapor-proof Fitting Enameled Steel Reflector with Glass Enclosing Globe** 90° to 180°—0% 0° to 90°—68%		Designed for locations where corrosive vapor, inflammable gases, or explosive dusts are likely to be encountered. In moisture laden atmospheres such as canning processes, engine rooms, shower baths; also where gases and vapors from such processes as oil refining, varnish making, spray lacquer painting and the like are present, units of this character are recommended. See also Unit No. 31. Coefficients of Utilization about 10 to 15% lower than for an open reflector.
31 **Vapor-proof Fitting Prismatic Enclosing Globe** 90° to 180°—28% 0° to 90°—57%		Applications same as for Unit No. 30; the glass reflector is usually not subject to corrosive action and holders are obtainable in a variety of metals and compositions to withstand corrosion from acid vapors of chemical plants. Recommended also in grain elevators, spice, flour and feed mills, in the manufacture of powdered sugar, cornstarch, sulphur, etc., where explosive dusts are present. Coefficients of Utilization about the same as for Unit No. 9.
32 **Angle Reflector Enameled Steel** Output 74%		Often used in craneways mounted below cranerail to supplement general overhead system in building up illumination on lateral surfaces. Used also to light individual machines where processes demand special distribution or direction of light. Special care must be taken in locating units to avoid glare; in general, they should be placed high.
33 **Local Lighting Unit Substantial Reflector and Holder Cover Plate** Output 45-55%		To supplement general lighting where operations require high levels of illumination of the order of 50 to 100 foot-candles where general lighting of at least 10 foot-candles is provided. Local lamps are subject to much handling and for this reason glass cover plates are recommended to protect reflecting surface from grease and dirt; construction must be substantial; reflectors should not be supported by socket shell. 25 to 60-watt inside frosted lamps will generally provide the level of illumination required.

COLOR QUALITY—APPLICATION OF ARTIFICIAL DAYLIGHT

A few years ago discussions of artificial daylight were centered about units built on theoretical lines and of somewhat uncertain performance. Today, good practical units are being marketed and consequently the field for such units has broadened beyond the original conception of limited applications in stores and textile industries.

The duplication of natural daylight is confined largely to those industrial and commercial applications involving accurate color discrimination or color rendition in varying degree, depending upon the specific requirements. Even in this field difficulties arise because the colorist has been accustomed, perhaps through years of habit, to a specific daylight quality peculiar to his location. It is practical and expedient, however, to provide exact reproductions of daylight for any given requirement with the attendant advantage of constancy and 24-hour availability.

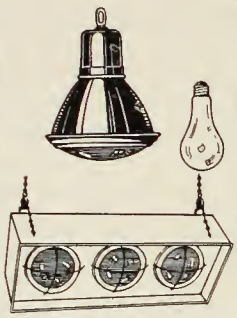
Although color quality is accurately specified by color temperature designations, equipments for reproducing daylight for working purposes may be grouped roughly into (1) skylight units, (2) sunlight units, and (3) units which provide a whiter light than the common types of general lighting equipment, but not so white as those listed under (1) and (2).

34

Skylight Quality

Special Color Filter

Clear Lamp



Equipments of this character employ accurately correcting filters by means of which it is possible to duplicate the color of outdoor daylight. Generally designed for *localized* lighting over counters in stores, for small areas or special operations in industrial plants where precision in color identification, grading, and other color inspection is required. Illumination of the order of 100 foot-candles is desirable for this sort of work.

Color factories, paint and dye mixing, art studios, chemical analysis, dental mechanics, surgery, textile and cigar sorting and grading are examples suggesting the application of skylight reproducing equipment.

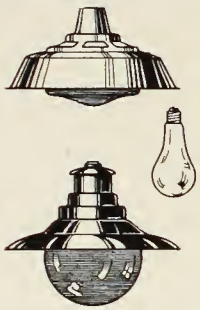
As compared to unmodified artificial light, from 6 to 8 times the wattage is required for the same foot-candle values.

35

Sunlight Quality

Reflector and Color Correcting Globe

Clear Lamp



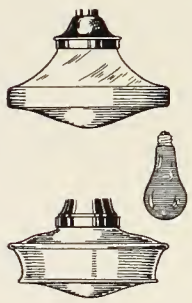
Enclosing globes of special crystal blue glass frosted on the inside modify the light from a lamp to approximate the color of direct sunlight at noon. Their applications are to some extent the same as skylight units, the actual choice depending on specific requirements; in general, noon sunlight equipment is used for less exacting color discrimination. For example, ink and dye mixing, and inspection may be done locally under skylight quality, and a general system of noon sunlight equipment may be installed in certain rooms or over small areas restricted to manufacturing operations requiring clear color rendition—such, for example, as lithographing processes, color printing and the like.

As compared to unmodified artificial light, from 2 to 3 times the wattage is required for the same foot-candle values.

36

Ordinary Equipment

Blue Bulb Daylight Lamps



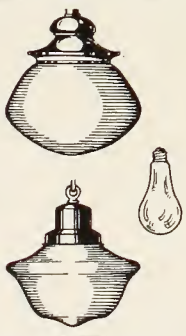
Lamps with blue bulbs, commercially known as MAZDA "Daylight" lamps, emit a whiter light which is but a partial step toward daylight whiteness. In many instances of color rendition, their use gives sufficient color correction to be of considerable advantage over the warmer tones of unmodified light. For example, they are widely used in stores and show windows to improve the display of merchandise. Again the light blends well with natural daylight; in fact in many cases it is about the same color as the daylight which one gets indoors taking into account the prevalence of warm tones in window shades, walls and hangings; for this reason the use of daylight lamps in offices and many other places will be found to correct an unsatisfactory mixture of ordinary artificial light and inadequate daylight.

The next larger size of lamp will be required to produce approximately the foot-candle level as computed for a clear lamp of a given size. They are used in all common types of equipment.

37

Color Modifying Globes

Clear Lamp



Enclosing globes with slight bluish ingredient do not appreciably modify the color quality of illumination for utilitarian purposes, but have a considerably field of application by virtue of their whiter appearance. Such equipment correct for the yellowish tone usually noticeably with ordinary opal glassware. These usually give far less color correction than MAZDA Daylight lamps. The units are very pleasing, appear white and clean, and are often more satisfactory than units of yellowish tone, particularly when supplementing natural daylight. The spectral quality of illumination is usually not far from that of a clear bulb MAZDA C lamp.

Coefficients of Utilization will be about 10% to 30% less than the values given for Unit No. 8.

4. Lamp Size—Lumen Output Required

TABLE 8—COMPUTED ILLUMINATION VALUES

In this table the actual foot-candles have been worked out for many different cases, assuming the average foot-candles in service to be 70 per cent of the initial illumination.

Area in Sq. Feet per Lamp	Size of Lamp		COEFFICIENT OF UTILIZATION															
	Watts	Lumens	.14	.16	.18	.20	.22	.25	.28	.32	.36	.40	.45	.50	.55	.60	.65	.70
			FOOT-CANDLES															
60	100	1350	2.2	2.5	2.8	3.2	3.5	3.9	4.4	5.0	5.7	6.3	7.1	7.9	8.7	9.5	10.2	11.0
	150	2300	3.8	4.3	4.8	5.4	5.9	6.7	7.5	8.6	9.7	10.7	12.1	13.4	14.8	16.1	17.4	18.8
	200	3200	5.2	6.0	6.7	7.5	8.2	9.3	10.5	11.9	13.4	14.9	16.8	18.7	20.5	22.4	24.3	26.1
	300	5300	8.7	9.9	11.1	12.4	13.6	15.5	17.3	19.8	22.3	24.7	27.8	30.9	34.0	37.1	40.2	43.3
70	100	1350	1.9	2.2	2.4	2.7	3.0	3.4	3.8	4.3	4.9	5.4	6.1	6.7	7.4	8.1	8.8	9.4
	150	2300	3.2	3.7	4.1	4.6	5.1	5.5	6.4	7.4	8.3	9.2	10.3	11.5	12.6	13.8	14.9	16.1
	200	3200	4.5	5.1	5.8	6.4	7.0	8.0	9.0	10.2	11.5	12.8	14.4	16.0	17.6	19.2	20.8	22.4
	300	5300	7.4	8.5	9.5	10.6	11.7	13.2	14.8	17.0	19.1	21.2	23.8	26.5	29.1	31.8	34.4	37.1
80	100	1350	1.7	1.9	2.1	2.4	2.6	3.0	3.3	3.8	4.3	4.7	5.3	5.9	6.5	7.1	7.7	8.3
	150	2300	2.8	3.2	3.6	4.0	4.4	5.0	5.6	6.4	7.2	8.1	9.1	10.1	11.1	12.1	13.1	14.1
	200	3200	3.9	4.5	5.0	5.6	6.2	7.0	7.8	9.0	10.1	11.2	12.6	14.0	15.4	16.8	18.2	19.6
	300	5300	6.9	7.4	8.3	9.2	10.2	11.5	12.9	14.8	16.7	18.5	20.8	23.2	25.5	27.8	30.1	32.5
90	100	1350	1.5	1.7	1.9	2.1	2.3	2.6	2.9	3.4	3.8	4.2	4.7	5.3	5.8	6.3	6.8	7.4
	150	2300	2.5	2.9	3.2	3.6	3.9	4.5	5.0	5.7	6.4	7.2	8.0	8.9	9.8	10.7	11.6	12.5
	200	3200	3.5	4.0	4.5	5.0	5.5	6.2	7.0	8.0	9.0	10.0	11.2	12.4	13.7	14.9	16.1	17.4
	300	5300	5.8	6.6	7.4	8.2	9.1	10.3	11.5	13.2	14.8	16.5	18.5	20.6	22.7	24.7	26.8	28.9
100	100	1350	1.3	1.5	1.7	1.9	2.1	2.4	2.6	3.0	3.4	3.8	4.3	4.7	5.2	5.7	6.1	6.6
	150	2300	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.2	5.8	6.4	7.2	8.1	8.9	9.7	10.5	11.3
	200	3200	3.1	3.6	4.0	4.5	4.9	5.6	6.3	7.2	8.1	9.0	10.1	11.2	12.3	13.4	14.6	15.7
	300	5300	5.1	5.9	6.7	7.4	8.2	9.3	10.4	11.9	13.4	14.8	16.7	18.6	20.4	22.3	24.1	26.0
110	100	1350	1.2	1.4	1.6	1.7	1.9	2.1	2.4	2.7	3.1	3.4	3.9	4.3	4.7	5.2	5.6	6.0
	150	2300	2.0	2.3	2.6	2.9	3.2	3.7	4.1	4.7	5.3	5.9	6.6	7.3	8.0	8.8	9.5	10.2
	200	3200	2.9	3.3	3.7	4.1	4.5	5.1	5.7	6.5	7.3	8.1	9.2	10.2	11.2	12.2	13.2	14.3
	300	5300	4.7	5.4	6.1	6.7	7.4	8.4	9.4	10.8	12.1	13.5	15.2	16.9	18.6	20.2	21.9	23.6
120	100	1350	1.1	1.3	1.4	1.6	1.7	2.0	2.2	2.5	2.8	3.2	3.5	3.9	4.3	4.7	5.1	5.5
	150	2300	1.9	2.1	2.4	2.7	3.0	3.4	3.8	4.3	4.8	5.4	6.0	6.7	7.4	8.0	8.7	9.4
	200	3200	2.6	3.0	3.4	3.7	4.1	4.7	5.2	6.0	6.7	7.5	8.4	9.3	10.3	11.2	12.1	13.1
	300	5300	4.3	4.9	5.6	6.2	6.8	7.7	8.7	9.9	11.1	12.4	13.9	14.5	17.0	18.5	20.1	21.6
130	150	2300	1.7	2.0	2.2	2.5	2.7	3.1	3.5	4.0	4.5	5.0	5.6	6.2	6.8	7.4	8.0	8.7
	200	3200	2.4	2.8	3.1	3.4	3.8	4.3	4.8	5.5	6.2	6.9	7.8	8.6	9.5	10.3	11.2	12.1
	300	5300	4.0	4.6	5.1	5.7	6.3	7.1	8.0	9.1	10.3	11.4	12.8	14.3	15.7	17.1	18.6	20.0
	500	9500	7.2	8.2	9.2	10.2	11.3	12.8	14.3	16.4	18.4	20.6	23.0	25.6	28.1	30.7	32.2	35.8
140	150	2300	1.6	1.8	2.1	2.3	2.5	2.9	3.2	3.7	4.1	4.6	5.2	5.8	6.3	6.9	7.5	8.1
	200	3200	2.2	2.6	2.9	3.2	3.5	4.0	4.5	5.1	5.8	6.4	7.2	8.0	8.8	9.6	10.4	11.2
	300	5300	3.7	4.2	4.8	5.3	5.8	6.6	7.4	8.5	9.5	10.6	11.9	13.3	14.6	15.9	17.2	18.6
	500	9500	6.7	7.6	8.6	9.5	10.5	11.9	13.3	15.2	17.1	19.0	21.4	23.8	26.1	28.5	30.9	33.3
150	150	2300	1.5	1.7	1.9	2.1	2.4	2.7	3.0	3.4	3.9	4.3	4.8	5.4	5.9	6.4	7.0	7.5
	200	3200	2.1	2.4	2.7	3.0	3.3	3.7	4.2	4.8	5.4	6.0	6.7	7.5	8.2	9.0	9.7	10.5
	300	5300	3.5	4.0	4.5	4.9	5.4	6.2	6.9	7.9	8.9	9.9	11.1	12.4	13.6	14.8	16.1	17.3
	500	9500	6.2	7.1	8.0	8.9	9.8	11.0	12.4	14.2	16.0	17.7	20.0	22.2	24.4	26.6	28.8	31.0
160	150	2300	1.4	1.6	1.8	2.0	2.2	2.5	2.8	3.2	3.6	4.0	4.5	5.0	5.5	6.0	6.5	7.0
	200	3200	2.0	2.2	2.5	2.8	3.1	3.5	3.9	4.5	5.0	5.6	6.3	7.0	7.7	8.4	9.1	9.8
	300	5300	3.2	3.7	4.2	4.6	5.1	5.8	6.5	7.4	8.3	9.3	10.4	11.6	12.8	13.9	15.1	16.2
	500	9500	5.8	6.7	7.5	8.3	9.1	10.4	11.6	13.3	15.0	16.6	18.7	20.8	22.9	24.9	27.0	29.1
170	150	2300	1.3	1.5	1.7	1.9	2.1	2.4	2.7	3.0	3.4	3.8	4.3	4.7	5.2	5.7	6.2	6.6
	200	3200	1.8	2.1	2.4	2.6	2.9	3.3	3.7	4.2	4.7	5.3	5.9	6.6	7.2	7.9	8.6	9.2
	300	5300	3.1	3.5	3.9	4.4	4.8	5.5	6.1	7.0	7.9	8.7	9.8	10.9	12.0	13.1	14.2	15.3
	500	9500	5.5	6.3	7.0	7.8	8.6	9.8	11.0	12.5	14.1	15.6	17.6	19.6	21.5	23.5	25.4	27.4
180	150	2300	1.3	1.4	1.6	1.8	2.0	2.2	2.5	2.9	3.2	3.6	4.0	4.5	4.9	5.4	5.8	6.3
	200	3200	1.7	2.0	2.2	2.5	2.7	3.1	3.5	4.0	4.5	5.0	5.6	6.2	6.8	7.5	8.1	8.7
	300	5300	2.9	3.3	3.7	4.1	4.5	5.2	5.8	6.6	7.4	8.2	9.3	10.3	11.3	12.4	13.4	14.4
	500	9500	5.2	5.9	6.6	7.4	8.1	9.2	10.3	11.8	13.3	14.8	16.6	18.5	20.3	22.2	24.0	25.9
190	150	2300	1.2	1.4	1.5	1.7	1.9	2.1	2.4	2.7	3.1	3.4	3.8	4.2	4.7	5.1	5.5	5.9
	200	3200	1.7	1.9	2.1	2.4	2.6	2.9	3.3	3.8	4.2	4.7	5.3	5.9	6.5	7.1	7.7	8.3
	300	5300	2.7	3.1	3.5	3.9	4.3	4.9	5.5	6.2	7.0	7.8	8.8	9.8	10.7	11.7	12.7	13.7
	500	9500	4.9	5.6	6.3	7.0	7.7	8.8	9.8	11.2	12.6	14.0	15.8	17.5	19.3	21.0	22.8	24.5

LAMP SIZE—LUMEN OUTPUT REQUIRED

TABLE 8—COMPUTED ILLUMINATION VALUES

After the layout has been made and the coefficient of utilization determined, the foot-candles produced by various sizes of lamps can be obtained directly from this table.

Area in Sq. Feet per Lamp	Size of Lamp		COEFFICIENT OF UTILIZATION															
	Watts	Lumens	.14	.16	.18	.20	.22	.25	.28	.32	.36	.40	.45	.50	.55	.60	.65	.70
			FOOT-CANDLES															
200	200	3200	1.6	1.8	2.0	2.2	2.5	2.8	3.1	3.6	4.0	4.5	5.0	5.6	6.2	6.7	7.3	7.8
	300	5300	2.6	3.0	3.3	3.7	4.1	4.6	5.2	5.9	6.7	7.4	8.3	9.3	10.2	11.1	12.1	13.0
	500	9500	4.7	5.3	6.0	6.7	7.3	8.3	9.3	10.6	12.0	13.3	15.0	16.6	18.3	20.0	21.6	23.3
	750	14800	7.3	8.3	9.3	10.4	11.4	13.0	14.5	16.6	18.6	20.7	23.3	25.9	28.5	31.1	33.7	36.3
220	200	3200	1.4	1.6	1.8	2.0	2.2	2.5	2.9	3.3	3.7	4.1	4.6	5.1	5.6	6.1	6.6	7.1
	300	5300	2.4	2.7	3.0	3.4	3.7	4.2	4.7	5.4	6.1	6.7	7.6	8.4	9.3	10.1	11.0	11.8
	500	9500	4.2	4.8	5.4	6.0	6.7	7.6	8.5	9.7	10.9	12.1	13.6	15.1	16.7	18.1	19.7	21.2
	750	14800	6.6	7.5	8.5	9.4	10.4	11.8	13.2	15.1	17.0	18.8	21.2	23.5	25.9	28.3	30.6	33.0
240	200	3200	1.3	1.5	1.7	1.9	2.1	2.3	2.6	3.0	3.4	3.7	4.2	4.7	5.1	5.6	6.1	6.5
	300	5300	2.2	2.5	2.8	3.1	3.4	3.9	4.3	4.9	5.6	6.2	7.0	7.7	8.5	9.3	10.0	10.8
	500	9500	3.9	4.4	5.0	5.5	6.1	6.9	7.8	8.9	10.0	11.1	12.5	13.9	15.2	16.6	18.0	19.4
	750	14800	6.0	6.9	7.8	8.6	9.5	10.8	12.1	13.8	15.6	17.3	19.4	21.6	23.7	25.9	28.1	30.2
260	200	3200	1.2	1.4	1.6	1.7	1.9	2.2	2.4	2.8	3.1	3.4	3.9	4.3	4.7	5.2	5.6	6.0
	300	5300	2.0	2.3	2.6	2.9	3.1	3.6	4.0	4.6	5.1	5.7	6.4	7.1	7.8	8.6	9.3	10.0
	500	9500	3.6	4.1	4.6	5.1	5.6	6.4	7.2	8.2	9.2	10.2	11.5	12.8	14.1	15.3	16.6	17.9
	750	14800	5.6	6.4	7.2	8.0	8.8	10.0	11.2	12.8	14.3	15.9	17.9	19.9	21.9	23.9	25.9	27.9
280	200	3200	1.1	1.3	1.4	1.6	1.8	2.0	2.2	2.6	2.9	3.2	3.6	4.0	4.4	4.8	5.2	5.6
	300	5300	1.9	2.1	2.4	2.6	2.9	3.3	3.7	4.2	4.8	5.3	6.0	6.6	7.3	7.9	8.6	9.3
	500	9500	3.3	3.8	4.3	4.8	5.2	5.9	6.7	7.6	8.6	9.5	10.7	11.9	13.1	14.3	15.4	16.6
	750	14800	5.2	5.9	6.7	7.4	8.1	9.3	10.4	11.8	13.3	14.8	16.7	18.5	20.4	22.2	24.1	25.9
320	200	3200	1.0	1.1	1.3	1.4	1.5	1.8	2.0	2.2	2.5	2.8	3.2	3.5	3.9	4.2	4.6	4.9
	300	5300	1.6	1.9	2.1	2.3	2.6	2.9	3.2	3.7	4.2	4.6	5.2	5.8	6.4	7.0	7.5	8.1
	500	9500	2.9	3.3	3.7	4.2	4.6	5.2	5.8	6.7	7.5	8.3	9.4	10.4	11.4	12.5	13.5	14.5
	750	14800	4.5	5.2	5.8	6.5	7.1	8.1	9.1	10.4	11.7	13.0	14.6	16.2	17.8	19.4	21.0	22.7
360	300	5300	1.4	1.6	1.9	2.1	2.3	2.6	2.9	3.3	3.7	4.1	4.6	5.2	5.7	6.2	6.7	7.2
	500	9500	2.6	3.0	3.3	3.7	4.1	4.6	5.2	5.9	6.6	7.4	8.3	9.2	10.2	11.1	12.0	12.9
	750	14800	4.0	4.6	5.2	5.8	6.3	7.2	8.1	9.2	10.4	11.5	13.0	14.4	15.8	17.3	18.7	20.1
	1000	21000	5.7	6.5	7.3	8.2	9.0	10.2	11.4	13.1	14.7	16.3	18.4	20.4	22.5	24.5	26.5	28.6
400	300	5300	1.3	1.5	1.7	1.9	2.0	2.3	2.6	3.0	3.3	3.7	4.2	4.6	5.1	5.6	6.0	6.5
	500	9500	2.3	2.7	3.0	3.3	3.7	4.2	4.7	5.3	6.0	6.7	7.5	8.3	9.1	10.0	10.8	11.6
	750	14800	3.6	4.1	4.7	5.2	5.7	6.5	7.3	8.3	9.3	10.4	11.7	13.0	14.2	15.5	16.8	18.1
	1000	21000	5.1	5.9	6.6	7.3	8.1	9.2	10.3	11.8	13.2	14.7	16.5	18.4	20.2	22.1	23.9	25.7
450	300	5300	1.2	1.3	1.5	1.6	1.8	2.1	2.3	2.6	3.0	3.3	3.7	4.1	4.5	4.9	5.4	5.8
	500	9500	2.1	2.4	2.7	3.0	3.3	3.7	4.1	4.7	5.3	5.9	6.7	7.4	8.1	8.9	9.6	10.3
	750	14800	3.2	3.7	4.1	4.6	5.1	5.8	6.4	7.4	8.3	9.2	10.4	11.5	12.7	13.8	15.0	16.1
	1000	21000	4.6	5.2	5.9	6.5	7.2	8.2	9.1	10.5	11.8	13.1	14.7	16.3	18.0	19.6	21.2	22.9
500	300	5300	1.0	1.2	1.3	1.5	1.6	1.9	2.1	2.4	2.7	3.0	3.3	3.7	4.1	4.5	4.8	5.2
	500	9500	1.9	2.1	2.4	2.7	2.9	3.3	3.7	4.3	4.8	5.3	6.0	6.7	7.3	8.0	8.6	9.3
	750	14800	2.9	3.3	3.7	4.2	4.6	5.2	5.8	6.7	7.5	8.3	9.4	10.4	11.4	12.5	13.5	14.6
	1000	21000	4.1	4.7	5.3	5.9	6.5	7.4	8.2	9.4	10.6	11.8	13.2	14.7	16.2	17.6	19.1	20.6
600	500	9500	1.6	1.8	2.0	2.2	2.4	2.8	3.1	3.5	4.0	4.4	5.0	5.5	6.1	6.6	7.2	7.8
	750	14800	2.4	2.8	3.1	3.5	3.8	4.3	4.8	5.5	6.2	6.9	7.8	8.6	9.5	10.4	11.2	12.1
	1000	21000	3.4	3.9	4.4	4.9	5.4	6.1	6.9	7.8	8.8	9.8	11.0	12.3	13.5	14.7	15.9	17.2
	1500	33000	5.4	6.2	6.9	7.7	8.5	9.6	10.8	12.3	13.9	15.4	17.3	19.3	21.2	23.1	25.0	27.0
700	500	9500	1.3	1.5	1.7	1.9	2.1	2.4	2.7	3.0	3.4	3.8	4.3	4.8	5.2	5.7	6.2	6.7
	750	14800	2.1	2.4	2.7	3.0	3.3	3.7	4.1	4.7	5.3	5.9	6.7	7.4	8.1	8.9	9.6	10.4
	1000	21000	2.9	3.4	3.8	4.2	4.6	5.3	5.9	6.7	7.6	8.4	9.5	10.5	11.6	12.6	13.7	14.7
	1500	33000	4.7	5.3	5.9	6.6	7.3	8.3	9.2	10.6	11.9	13.2	14.9	16.5	18.2	19.8	21.5	23.1
800	500	9500	1.2	1.3	1.5	1.7	1.8	2.1	2.3	2.7	3.0	3.3	3.7	4.2	4.6	5.0	5.4	5.8
	750	14800	1.8	2.1	2.3	2.6	2.8	3.2	3.6	4.1	4.7	5.2	5.8	6.5	7.1	7.8	8.4	9.1
	1000	21000	2.6	2.9	3.3	3.7	4.0	4.6	5.1	5.9	6.6	7.4	8.3	9.2	10.1	11.0	11.9	12.9
	1500	33000	4.0	4.6	5.2	5.8	6.4	7.2	8.1	9.2	10.4	11.6	13.0	14.4	15.9	17.3	18.8	20.2
900	500	9500	1.0	1.2	1.3	1.5	1.6	1.8	2.1	2.4	2.7	3.0	3.3	3.7	4.1	4.4	4.8	5.2
	750	14800	1.6	1.8	2.1	2.3	2.5	2.9	3.2	3.7	4.1	4.6	5.2	5.8	6.3	6.9	7.5	8.1
	1000	21000	2.3	2.6	2.9	3.3	3.6	4.1	4.6	5.2	5.9	6.5	7.3	8.2	9.0	9.8	10.6	11.4
	1500	33000	3.6	4.1	4.6	5.1	5.6	6.4	7.2	8.2	9.2	10.3	11.6	12.8	14.1	15.4	16.7	18.0

Formulas for Computing Lamp Size

After the outlets have been located on the plan, the size of lamp to be used may be determined by the following calculation:

$$\text{(A)}\quad \text{Area in Square Feet per Outlet} = \frac{\text{Total Floor Area in Square Feet}}{\text{Number of Outlets}}$$

$$\text{(B)}\quad \text{Lamp Lumens Required per Square Foot} = \frac{\text{Foot-Candles}}{\text{Coefficient of Utilization} \times \text{Probable Average Illumination in Per Cent of Initial Illumination}}$$

$$\text{(C)}\quad \text{Lamp Lumens Required per Outlet} = \text{Area in Square Feet per Outlet (From A)} \times \text{Lamp Lumens Required per Square Foot (From B)}$$

Having determined the lamp lumens required per outlet by the above calculations, the wattage of MAZDA lamps to be used may be found by reference to Table 9, below, which lists the lumen output rating for each size of MAZDA clear and MAZDA Daylight lamps. Locate in this table the size of lamp of the desired type which most nearly meets the requirements of lumen output. When the lamp lumens required fall nearly midway between two sizes, it will usually be found best to choose the larger size.

TABLE 9—LUMEN OUTPUT OF MULTIPLE MAZDA LAMPS

Subject to change without notice

110-115-120 Volt Standard Lighting Service Clear Lamps		110-115-120 Volt Standard Lighting Service MAZDA Daylight Lamps		220-230-240-250 Volt Service Clear Lamps	
Size of Lamp in Watts	Lumen Output	Size of Lamp in Watts	Lumen Output	Size of Lamp in Watts	Lumen Output
100	1350	100	900	100	1040
150	2300	150	1500	....	.....
200	3200	200	2100	200	2700
300	5300	300	3500	300	4300
500	9500	500	6200	500	8100
750	14800	....	.....	750	13000
1000	21000	....	.....	1000	18200
1500	33000	....	.....	1500	27300

LIST OF MANUFACTURERS

MANUFACTURER	TRADE NAME OF UNIT
Unit No. 1 (60 to 1500 watts)	
*Benjamin Electric Manufacturing Co.	RLM Standard Dome
*Ivanhoe Division of the Miller Co.	
*Westinghouse Electric and Manufacturing Co.	
*Wheeler Manufacturing Co.	
*National Screw and Manufacturing Co.	
Overbagh and Ayres Manufacturing Co.	
Quadrangle Manufacturing Co.	
Central States G. E. Supply Co.	
Unit No. 2 (150 to 500 watts)	
Manufacturers marked (*) under Unit No. 1	Glassteel Diffuser
Unit No. 3 (60 to 500 watts)	
Ivanhoe Division of the Miller Co.	RLM Dust-tight
Benjamin Electric Manufacturing Co.	
Wheeler Reflector Co.	
Unit No. 4 (60 to 1500 watts)	
Same as for Unit No. 1	RLM Standard Dome
Unit No. 5 (500 to 1500 watts)	
Holophane Glass Co.	Holophane
Unit No. 6 (750 to 1500 watts)	
Pittsburgh Reflector Co.	Permaflector
Curtis Lighting, Inc.	Jumbo
Unit No. 7 (750 to 1500 watts)	
Ivanhoe Division of the Miller Co.	Industrial Flood

Unit No. 8 (100 to 500 watts)

Flattened globes of this character are made by most lighting glassware manufacturers and marketed under various trade names. The best quality will have a light output of about 80% and yet be sufficiently diffusing that the globe is of uniform brightness. The minimum diameter of globe for a given lamp wattage is as follows:

150 watts.....12-inch	300 watts.....16-inch
200 watts.....14-inch	500 watts.....18-inch

Unit No. 9 (100 to 500 watts)	
Holophane Glass Co.	RR (Reflector-Refractor)
Unit No. 10 (100 to 500 watts)	
Goodrich Electric Co.	Clear Top
Beardslee Chandelier Co.	
Henkel and Best Co.	
Unit No. 11 (100 to 500 watts)	
Graybar Electric Co., Inc.	99 Reflex
Unit No. 12 (100 to 300 watts)	
Wakefield Brass Co.	Red Spot Office Unit
Unit No. 13 (150 to 500 watts)	
Ivanhoe Division of the Miller Co.	Keldon
Unit No. 14 (100 to 500 watts)	
Holophane Glass Co.	Filterlite
Unit No. 15 (100 to 1500 watts)	
Duplexalite Division of the Miller Co.	Duplexalite
Unit No. 16 (200 to 500 watts)	
Curtis Lighting, Inc.	X-Ray Luminous Bowl

LIST OF MANUFACTURERS

MANUFACTURER	TRADE NAME OF UNIT
Unit No. 17 (100 to 1500 watts)	
Curtis Lighting, Inc.	X-Ray
Unit No. 18 (25 to 150 watts)	
Made by most Lighting Glassware Manufacturers.	
Unit No. 19 (60 to 1000 watts)	
Made by most Lighting Glassware Manufacturers.	
Unit No. 20 (100 to 500 watts)	
Planetlite Company, Inc.	Planetlite
Edwin F. Guth	Brascolite
Unit No. 21 (100 to 500 watts)	
Art stores and studios, in general, make a specialty of executing designs in silk, parchment, and other suitable shade materials.	
Unit No. 22 (100 to 500 watts)	
The Duplexalite Division of the Miller Company	Duplexalite
Units Nos. 23, 24, 25	
Specifically designed ornamental equipments will be made up according to specification by a considerable number of lighting fixture manufacturers.	
Unit No. 26 (25 to 1500 watts)	
Same as list for Unit No. 1	Deep Bowl Steel
Unit No. 27 (100 to 500 watts)	
Holophane Glass Co.	Holophane Prismatic
Unit No. 28 (100 to 500 watts)	
Curtis Lighting, Inc.	
Unit No. 29 (200 to 500 watts)	
Ivanhoe Division of the Miller Co.	Industrial Floodlight
Unit No. 30 (60 to 500 watts)	
Benjamin Electric Manufacturing Co.	Vapor Proof
Ivanhoe Division of the Miller Co.	
Wheeler Reflector Co.	
Unit No. 31 (40 to 200 watts)	
Holophane Glass Co.	Vapor Proof
Unit No. 32 (25 to 1500 watts)	
Same as list for Unit No. 1	Angle Type
Unit No. 33 (10 to 50 watts)	
Ivanhoe Division of the Miller Co.	
Benjamin Electric Manufacturing Co.	
Unit No. 34 (150 to 1000 watts and in multiple units)	
MacBeth Daylighting Co.	MacBeth
Ivanhoe Division of the Miller Co.	Trutint
Unit No. 35 (200 to 1000 watts)	
Ivanhoe Division of the Miller Co.	Noon Sunlight
Unit No. 36 (60 to 500 watts)	
Mazda Lamp Manufacturers	Mazda Daylight Lamp
Unit No. 37 (100 to 750 watts)	
Gleason-Tiebout Glass Co.	Celestialite Glass

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